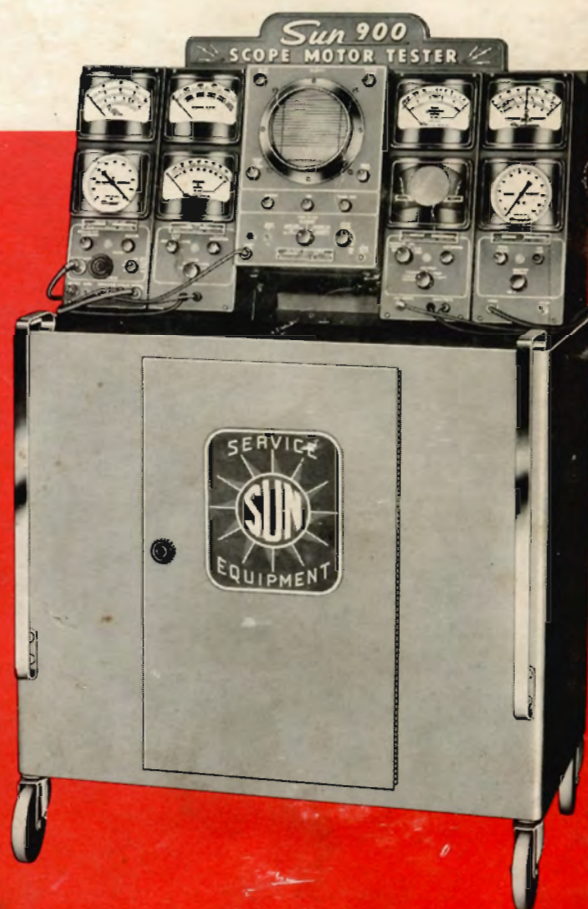




INSTRUCTION MANUAL

800 MOTOR TESTER AND 900 SCOPE MOTOR TESTER



A guide to Expert Engine Service

SUN ELECTRIC CORPORATION

HARLEM & AVONDALE

CHICAGO 31, ILLINOIS

BRANCHES IN ALL PRINCIPAL CITIES

THE SUN 800 AND 900 MOTOR TESTERS...

The World's Finest Automotive Testing Equipment



The Sun 800 MOTOR TESTER

TESTS

Cranking Voltage • Charging Voltage • Battery Cables • Ignition Primary Circuit Resistance • Primary Circuit Insulation • Battery Leakage • Ignition Efficiency • Secondary Resistance • Secondary Polarity • Initial Ignition Timing • Ignition Timing Advance • Cylinder Leakage • Distributor Resistance • Distributor Point Dwell • Dwell Variation • Engine Speed • Condenser Resistance • Condenser Capacity • Condenser Leakage • Coil Primary Windings • Coil Secondary Windings • Ignition Coil Insulation • Manifold Vacuum • Cranking Vacuum • Exhaust Restriction • Fuel Pump Vacuum • Vacuum Booster Pump • Combustion Efficiency

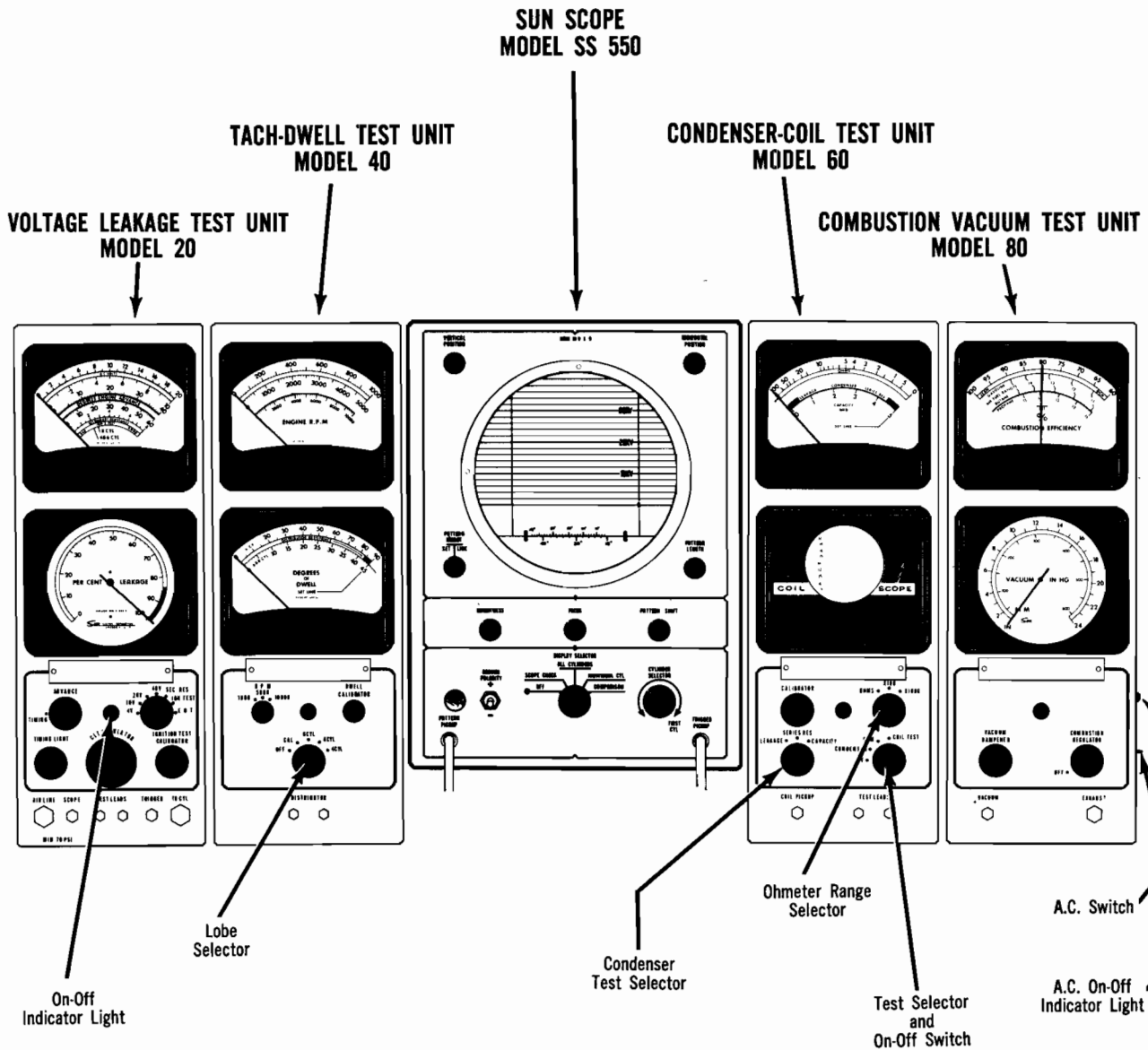
The Sun 900 SCOPE MOTOR TESTER

TESTS

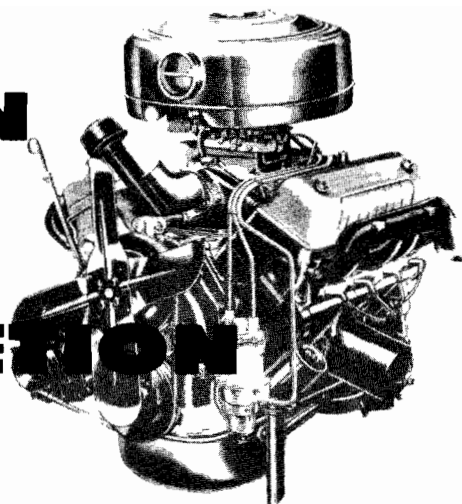
Cranking Voltage • Charging Voltage • Battery Cables • Ignition Primary Circuit Resistance • Primary Circuit Insulation • Battery Leakage • Ignition Efficiency • Secondary Resistance • Secondary Polarity • Initial Ignition Timing • Ignition Timing Advance • Cylinder Leakage • Distributor Resistance • Distributor Point Dwell • Dwell Variation • Engine Speed • Condenser Resistance • Condenser Capacity • Condenser Leakage • Coil Primary Windings • Coil Secondary Windings • Ignition Coil Insulation • Manifold Vacuum • Cranking Vacuum • Exhaust Restriction • Fuel Pump Vacuum • Vacuum Booster Pump • Combustion Efficiency • Ignition Coil Output during Cranking • Ignition Coil Polarity • Ignition Firing Requirements • Available Secondary Ignition Voltage • Ignition Reserve • Coil and Condenser Condition • Breaker Point Action • Dwell Angle Comparison • Point Arcing • Point Bounce • Erratic Point Closing • Distributor Cam Lobe Accuracy • Spark Plug Conditions



IDENTIFICATION OF TESTER UNITS AND CONTROLS



COMPRESSION IGNITION CARBURETION



The Secrets of Top-Notch Engine Performance

Satisfactory engine performance depends on three important factors: — *COMPRESSION*, *IGNITION*, and *CARBURETION*.

An engine, having poor compression due to excessive leakage, will not develop full power. If the engine compression and carburetion were normal, but the ignition system had burned points and fouled or worn spark plugs, the engine would not develop power. The engine would not develop full power if the carburetion system had worn valve guides, leaky intake manifold gaskets, dirty carburetor, or any other defect that would affect the fuel-air mixture going to the cylinder. As can readily be seen, engine performance depends on *all* systems performing normally. Defects or malfunctions in any one of the systems, affects the ability of the engine to produce full power.

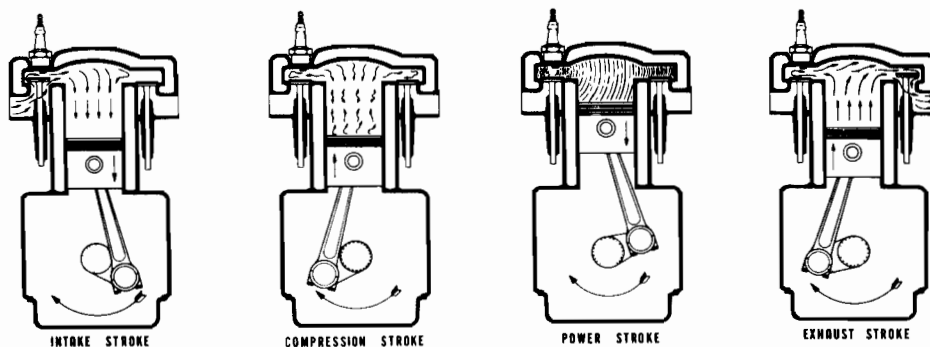
On a engine having a $3\frac{1}{2}$ inch diameter piston and 150 PSI compression, the force created by the burning fuel-air mixture would be approximately 3 tons.

On a six cylinder engine operating at 3,000 RPM, the ignition points will make and break 9000 times in one minute, or 540,000 times in one hour.

The fuel in the carburetor main metering jets will attain speeds up to 150 feet per second, or approximately 100 miles per hour. This carburetor, in 100,000 miles, will mix one cubic mile of air with one tank car of gasoline.

FOUR STROKE CYCLE

Most engines have a four stroke cycle.



INTAKE: — starting with the piston at the top of the cylinder, it first moves down creating a low pressure or vacuum in the cylinder. The outside air pressure forces a mixture of air-fuel into the cylinder through the open intake valve.

COMPRESSION:—the piston then moves upward with both the exhaust and intake valves closed and compresses the air-fuel mixture to a pressure specified by the manufacturer.

POWER:—just before the piston reaches the top of the cylinder, a spark occurs at the spark plug and ignites the air-fuel mixture. The burning air-fuel mixture increases the compression and forces the piston down.

EXHAUST: — the piston then again moves upward with the exhaust valve open, forcing the burned gases out of the cylinder into the exhaust system. This cycle is repeated several thousand times a minute at normal driving speeds.

COMPRESSION

The compression of the engine must meet manufacturer's specifications in order to develop full power. This means that there must be no leakage in the cylinder. The intake and exhaust valves, the gaskets, and piston rings must all function properly and allow no leakage for full power output. An engine with leakage in one or more cylinders will have uneven power strokes which results in rough operation, and in a proportionate reduction in performance and economy.

IGNITION

The ignition spark must occur at the correct time and with sufficient intensity to ignite the compressed fuel-air mixture. All components of the ignition system must function properly for satisfactory and economical operation.

The coil must be able to transform the low primary voltage to a secondary voltage high enough to supply sufficient spark for all conditions of load and speed. The ignition distributor must perform two jobs. It must distribute the high tension secondary voltage to the spark plugs in proper sequence. It must also open the ignition points at the proper time to fire the spark plugs at just the right instant for the engine to develop full power.

At high speeds, the spark must occur at the plug earlier in the compression stroke in order to give the fuel-air mixture ample time to ignite, burn, and apply its power to the piston as it starts down on the power stroke. Varying spark timing in relation to change in engine speed is accomplished by the centrifugal advance mechanism of the distributor.

During part throttle operation, or cruising, the fuel mixture is drawn into the cylinder through a restricted opening and is less dense. The less dense mixture will burn slower and additional advance is necessary for good economy. This additional advance is furnished by the vacuum advance unit. A vacuum advance unit is controlled by the vacuum in the intake manifold. The centrifugal advance will advance ignition timing with increases in engine speed and the vacuum advance operates in relation to throttle position and engine load.

CARBURETION

The carburetor must deliver the right mixture of air and fuel for all conditions of load and speed. It automatically controls the amount of fuel being mixed with air to meet the chang-

ing engine operating conditions, delivering a great amount of fuel when high power output is required and less fuel for economical cruising. The carburetor makes use of the engine vacuum and the atmospheric pressure to meter the air-fuel mixture.

Improper carburetor operation can cause a rich or lean mixture, which in either case would cause poor engine operation and accelerate engine wear. A rich mixture would be uneconomical, causing plug fouling and loss of power. A lean mixture in turn would cause overheating, pre-ignition, loss of power and possibly engine damage. The carburetor, even when in good condition, cannot perform properly if the rest of the components in the fuel system are not in satisfactory condition. The fuel pump must supply an adequate volume of fuel at the correct pressure to prevent starving or flooding of the carburetor.

The intake manifold, the intake and exhaust valves, the piston, and cylinder must all be considered as part of the carburetion system. Without proper vacuum, due to leaky intake manifold gaskets, burned valves or worn rings, the carburetor cannot efficiently meter the correct air-fuel mixture to the engine.

STARTING SYSTEM

For dependable vehicle operation, the efficient operation of the starting system must not be overlooked. The starting system is used to crank the engine until it can continue running under its own power. The starting system consists of an electric motor to crank the engine, a battery to furnish the electrical energy to operate the cranking motor and the ignition system, and a switch to complete the circuit between the battery and the motor. This switch usually is an electrically operated switch called a solenoid.

CHARGING SYSTEM

The charging system is used to furnish electrical power to all accessories, to the ignition system and also recharge the battery. The charging system consists of a generator, a regulator and a battery.

The generator converts mechanical energy furnished by the engine, into electrical energy. Its output is controlled by a regulator assembly generally consisting of three units, the cutout, voltage regulator and current regulator.

The cutout is a switch that connects the generator to the battery when the generator voltage is higher than battery voltage. It prevents the battery from discharging through the generator when the generator is not charging. The voltage limiter limits the voltage output to a safe level for the accessories and the battery and the current regulator limits the current output and protects the generator.

The battery is the stabilizer in the charging system.

TESTING

It has been firmly established that the quickest, easiest, and most reliable method to determine the service requirements of an engine is through the medium of scientific testing. The factual information obtained from a practical series of tests, when compared with specifications and known standards, provides an accurate picture of an engine's condition. Once the true condition of an engine has been determined, a good mechanic should have no difficulty in recommending the proper service necessary to restore the engine to full operating efficiency.

HOW TO USE THIS HANDBOOK

To fully utilize all of the facilities of your test equipment, and thereby realize its many values and applications in your service operation, it is suggested that you carefully study the sections of this Handbook that pertain to the pieces of test equipment in your possession.

For your convenience, this handbook is designed to provide application and use data pertinent to a number of testers which can be used individually or in many combinations. As you will note, a complete section, detailed as to application, procedure, results and indications, is provided for each test unit. In addition, a complete sequence of tests, combining the facilities of all the testers, is outlined for the more skilled operator under the heading of "Condensed Test Procedure."

Each step in the Condensed Procedure sequence is labeled to indicate what information is to be gained, and is also identified with the particular tester required to perform the test. When the need for more detailed tests of a given area are required, the operator need only refer to the section of the handbook dealing with the specific tester involved.

Whether your shop is equipped with the Model 800 or the Model 900 which are covered in this publication, it will be to your advantage to review its various sections periodically to make sure you are not overlooking any of the many valuable functions and applications of the test equipment at your disposal.

TESTER MAINTENANCE

SUN test equipment is the finest available and retains its accuracy and long life with a minimum of care. The test leads can be quickly cleaned with waterless soap or solvent. Do not use gasoline as it will deteriorate the rubber. The metal work can be kept glossy with any good automobile polish. To assure accurate test results, meter pointers must read zero when all tester switches are off. To zero a meter, turn the adjustment button on the face of the meter.

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Engine Tune-Up Test Report

ORDER NO. _____

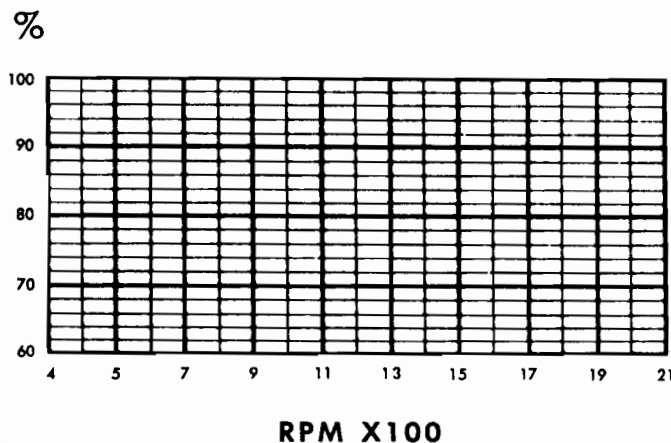
CUSTOMER NAME _____ DATE _____

ADDRESS _____ PHONE _____

MAKE _____ MODEL _____ MILEAGE _____ LICENSE NO. _____

CUSTOMER COMMENTS: _____

TESTS	SPECS.	RESULTS	RECOMMENDATIONS
Cylinder Leakage	20% or Less		1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____
Spark Plug Inspection			
Cranking Voltage			
Cranking Vacuum			
Distributor Resistance	Black Bar		
Coil-Output-Cranking	+ 20KV		
Dwell			
Dwell Variation			
Initial Timing			
Timing Advance			
Coil Polarity			
Plug Firing Voltage			
Available Voltage			
Secondary Insulation			
Secondary Resistance			
Spark Plugs Under Load			
Point Action			
Coil and Condenser			
Fuel Pump-Pressure			
Volume			
Carburetor Tests			
Idle			
Intake Manifold			
Intermediate			
High			
Accelerating			
Air Cleaner			
Charging Voltage			
Final Idle Adjustment			
STARTING SYSTEM			
Battery Capacity			
Cables & Switches			
Starter Amp. Draw			
CHARGING SYSTEM			
Circuit Resistance			
Generator Output			
Cut-Out Relay			
Voltage Regulator			
Current Regulator			



CONDENSED TEST PROCEDURE

The Condensed Test Procedure outlined in this section of the Handbook is designed primarily for the operator who has already acquired some degree of skill in using the individual test instruments at his disposal and interpreting the test results obtained. Note that each step in the Condensed Test Procedure is "keyed", indicating which test instrument is being utilized to perform each test. (If your tester is equipped with the Sun Scope, omit steps 17 and 18. If your tester is not equipped with a Sun Scope, omit step 4 and steps 9 through 16.

A Condensed Test Procedure is quite valuable for a number of reasons. For the purpose of determining exactly what specific services will be required, prior to writing a work order, it may be used to quickly determine the condition of the five important power plant areas. The Condensed Test Procedure may also be used in conjunction with the actual tune-up operation. In this manner, the test instruments are used to assist in making the various tune-up adjustments and calibrations. In addition, the Condensed Test Procedure, as a whole or in part, may perform a quality control function: the tests being performed prior to vehicle delivery to make sure that all necessary work had been completed, and that the powerplant is now operating at top efficiency.

1. Cylinder Leakage . . . (Voltage Leakage Unit)

- a. Remove Spark Plugs.
- b. Remove air cleaner, crank case filler cap and radiator cap. Set throttle valve to wide open position and fill radiator to prescribed level.
- c. Connect shop air line to tester and calibrate tester.
- d. Install adapter in No. 1 spark plug hole and attach whistle.
- e. Use whistle to locate TDC of No. 1 cylinder.
- f. Install TDC indicator and connect indicator light to distributor.
- g. Connect tester hose and note percentage of leakage. Listen for sound of leakage at carburetor, oil filler, tail pipe and check for bubbles at the radiator.
- h. Disconnect tester hose, rotate engine to next marker on TDC indicator.
- i. Install adapter in next cylinder in engine's

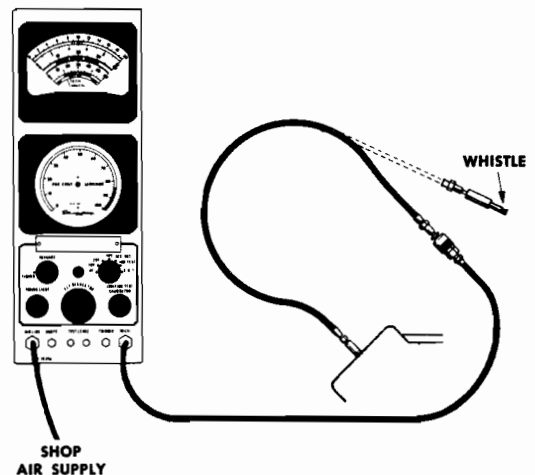
2. Spark Plug Visual Inspection

Inspect spark plugs for the following:

- a. Physical condition...cracks, chips, blow-by marks indicating leakage oxidation and erosion of electrodes.
- b. Electrode gap...use wire gauge to measure gap and compare with manufacturer's specifications.
- c. Heat range...note heat range of plugs and compare with manufacturer's specifications.

It is suggested that all the pertinent specifications and data applicable to the vehicle being tested be first recorded on a Test Report Form, such as the one illustrated on the adjoining page. In this manner, the operator is assured of having all the necessary information readily available for reference during the test sequence. In reviewing the Condensed Test Procedure and the arrangement of the Test Report Form, it is readily apparent that both follow a similar, step-by-step arrangement. The Test Report Form serves an important function in the service operation if the results of each test are recorded on it. The completed report can then be used later as a guide in writing the shop work order, or as a factual reference in discussing service requirements with the vehicle owner.

As you will note, the Cylinder Leakage Test and Spark Plug Visual Inspection are listed as preliminary steps to the Condensed Test Procedure. The final results of any tune-up work performed depend to such a great extent on the condition of the engine itself that it is highly recommended that a Cylinder Leakage Test become a step in every major tune-up or engine service operation. Naturally, when service work is being confined to just one or two areas or systems of a vehicle, only the applicable portions of the Condensed Procedure need be used.



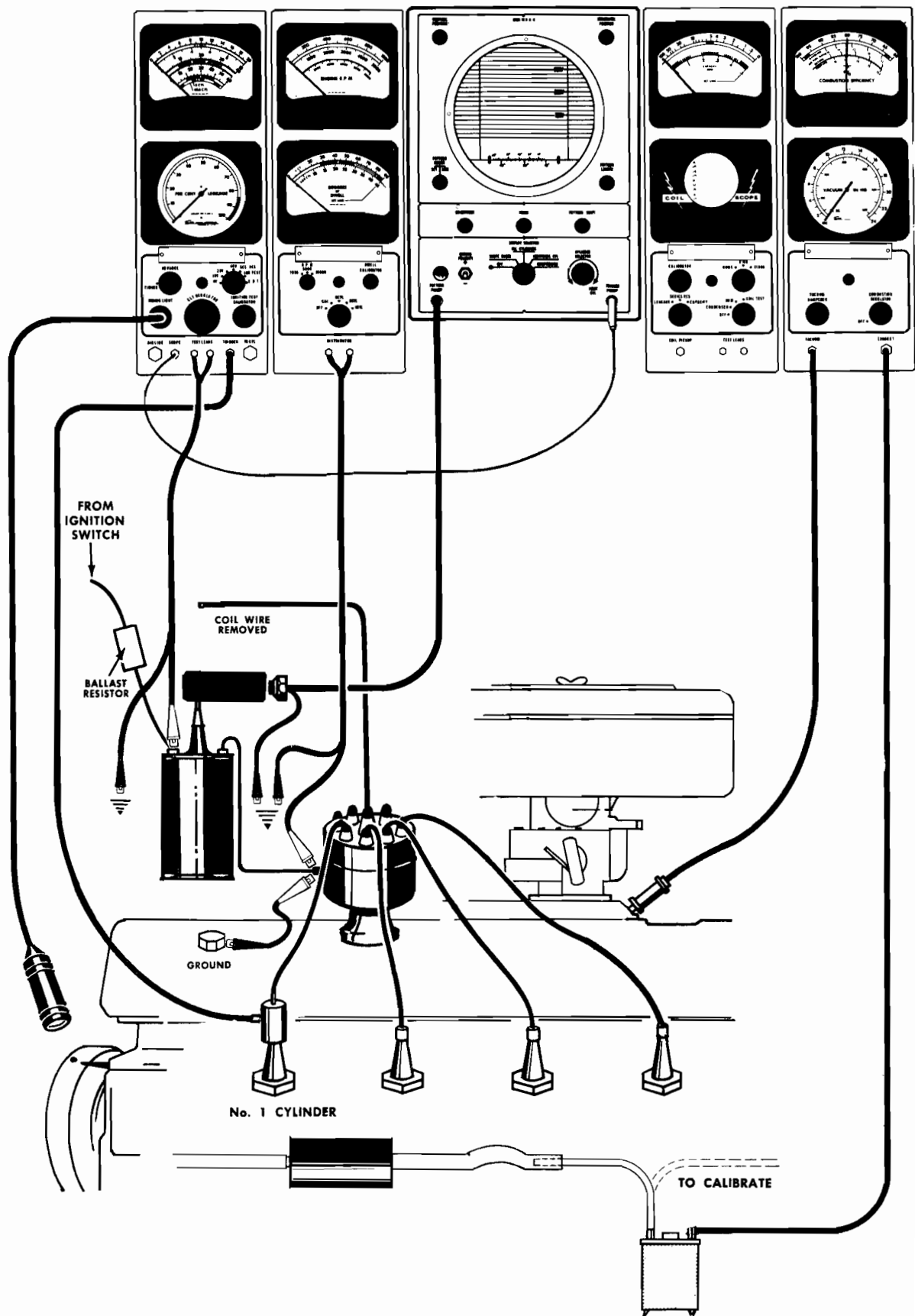
firing order and repeat test.

- j. Repeat test on all cylinders, following sequence of engine's firing order.

If plugs are of the specified range, but appear to be operating either too hot or too cold, find the cause. **DO NOT RECOMMEND A CHANGE IN PLUG HEAT RANGE TO COMPENSATE FOR TROUBLE ELSEWHERE IN THE ENGINE!**

- d. Clean, file electrodes and adjust gap; or replace plugs as visual inspection warrants. Reinstall spark plugs.

Connections to Vehicle



POWER LEAD

1. Plug cord into proper outlet.
2. Place AC master switch in "ON" position.

TACH-DWELL UNIT 40

1. Turn selector switch to CALIBRATE position and adjust Dwell Calibrator until meter pointer reads on SET LINE.
2. Set RPM switch to 5,000 position.
3. Connect Tach-Dwell leads to primary distributor lead at coil, and to ground. Observe proper polarity. Black insulator is negative, Red insulator is positive.

VOLTAGE LEAKAGE UNIT 20

1. Connect Trigger Pickup into circuit of No. 1 spark plug in firing order.
2. Turn Advance Control counterclockwise to TIMING position.
3. Connect jumper lead from distributor primary to ground.
4. Set switch to voltage position which corresponds to vehicle voltage.
5. Observing proper polarity, connect leads to battery side of coil and to ground.

COMBUSTION VACUUM UNIT 80

1. Connect vacuum hose to intake manifold.

2. Rotate Combustion Regulator clockwise from "OFF" position.

NOTE: IF TESTER IS NOT EQUIPPED WITH SCOPE, PROCEED WITH FUEL PUMP TESTER CONNECTIONS.

SUN SCOPE 550

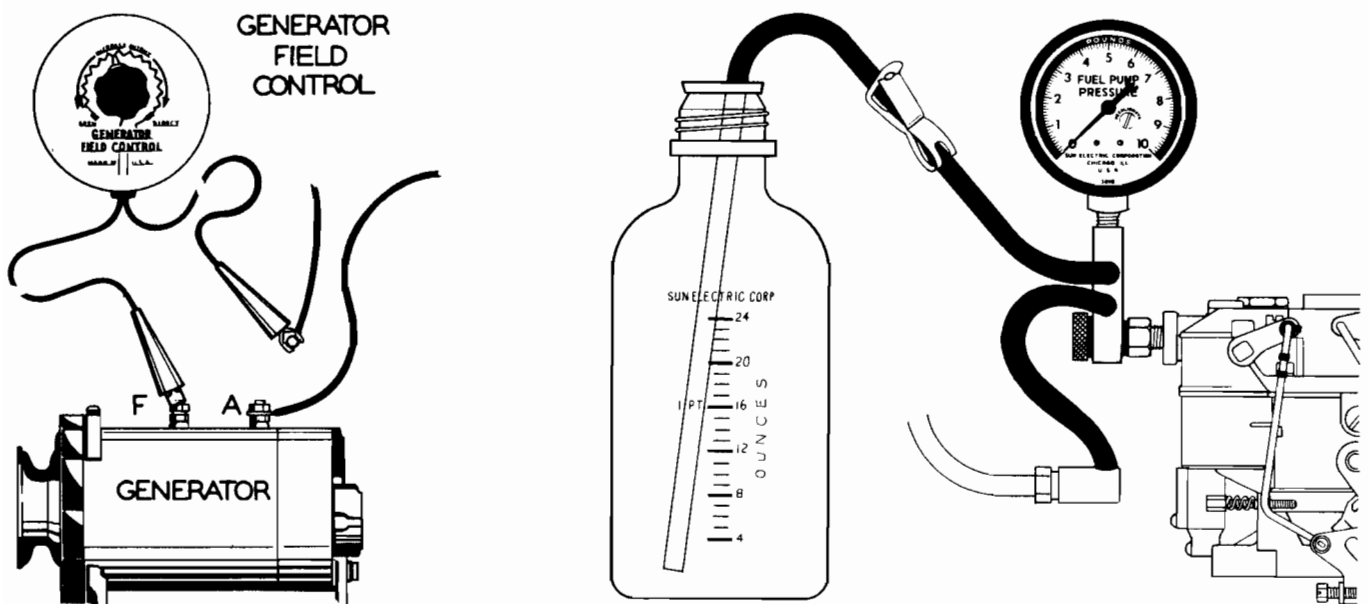
1. Remove high tension wire from coil and leave wire disconnected.
2. Insert Pattern Pickup into coil tower and attach the ground clip to the engine.
3. Set polarity switch to POSITIVE position.
4. Turn display selector to SCOPE CHECK position and adjust Scope until trace appears on "ZERO" line.

FUEL PUMP TESTER

1. Disconnect main fuel line at carburetor and mount Fuel Pump Tester to carburetor fuel fitting.
2. Connect vehicle's fuel line to fitting on Fuel Pump Tester hose.

GENERATOR FIELD CONTROL

1. Disconnect generator field wire.
2. Attach GFC leads; one to end of field wire, the other to the terminal.
3. Set GFC to OPEN position.



① Cranking Voltage . . . (Voltage Leakage Unit)

a. Turn Ignition Switch "ON" (for safety, set parking brake and shift transmission to neutral.)

b. Crank engine, observe cranking speed and note reading on Voltmeter.

b. Insert high tension coil wire into pattern pickup.

c. Start engine, run at specified idle speed, and read Dwell.

⑥ Dwell Variation . . . (Tach-Dwell Unit)

a. Slowly increase engine speed to 1500 RPM and return to idle speed.

b. Observe Dwell Meter for variation in reading. (See specifications)

② Cranking Vacuum . . . (Combustion Vacuum Unit)

a. Back out throttle stop screw and release automatic choke so that throttle valves can seat tightly.

b. Crank engine, noting vacuum gauge reading.

⑦ Initial Ignition Timing . . . (Voltage Leakage Unit)

a. Set RPM Switch to 1000 position.

b. Operate engine at specified timing speed, and note timing. Adjust if necessary.

③ Distributor Resistance . . . (Tach-Dwell Unit)

a. Remove jumper lead from distributor.

b. With Ignition Switch on, Dwell Meter should read in black bar at right end of scale.

⑧ Ignition Timing Advance . . . (Voltage Leakage Unit)

a. Reconnect vacuum line to distributor if removed for preceding test.

b. Set RPM Switch to 5000 position.

c. Adjust engine speed to 2500 RPM and adjust Advance Control until timing mark appears in its original position. Read degrees of advance on tester meter.

d. Reduce engine speed.

④ Coil Output Voltage At Cranking Speed . . . (Sun Scope)

a. With Ignition Switch on, crank engine.

b. Observe coil output voltage on the Scope screen.

⑤ Dwell . . . (Tach-Dwell Unit)

a. Set lobe selector to proper position.

NOTE: IF TESTER IS NOT EQUIPPED WITH SUN SCOPE PROCEED WITH STEP 17.

9 Coil Polarity . . .
(Sun Scope)

- a. Adjust engine speed to 1200 RPM.
- b. Turn Scope Display Selector to ALL CYLINDERS position, and adjust the Pattern Length Control until all cylinders appear between the vertical lines on both sides of the screen.
- c. Rotate Pattern Shift Control counterclockwise until last pattern on screen appears complete.
- d. Observe patterns, noting whether they are upright or inverted.

10 Required (Firing) Voltage . . .
(Sun Scope)

- a. Observe height of each firing line and compare firing lines for uniformity of height.

11 Available Voltage . . .
(Sun Scope)

- a. Disconnect secondary wire from spark plug using insulated pliers.
- b. Observe upward extent of pattern on Scope.

12 Secondary Insulation . . .
(Sun Scope)

- a. Observe downward extent of pattern of cylinder with spark plug wire removed.
- b. Reconnect wire to spark plug.
- c. Test secondary circuit to other cylinders in the same manner. (Trigger cylinder may be tested in "SCOPE CHECK" position)

13 Secondary Resistance . . .
(Sun Scope)

- a. Place Scope display Selector Switch in "ALL CYLINDERS" position.
- b. Observe and compare spark line of patterns for height, length, angle and oscillations.

14 Spark Plugs Under Load . . .
(Sun Scope)

- a. With Display Selector set in "ALL CYLINDERS" position rotate pattern shift control "FULL CLOCKWISE".
- b. Momentarily accelerate engine to approximately 2000 RPM, then allow engine speed to return to 1200 RPM.
- c. Observe rise of firing lines during momentary engine acceleration.

15 Point Condition And Action . . .
(Sun Scope)

- a. Turn Display Selector to the INDIVIDUAL CYLINDER position.
- b. Observe point CLOSE and point OPEN signal.

16 Coil And Condenser . . .
(Sun Scope)

- a. Observe and note the number of oscillations in the intermediate section of the scope patterns.
- b. Reduce engine speed to idle.

**NOTE: IF TESTER IS EQUIPPED WITH
SUN SCOPE PROCEED TO STEP 19.**

17 Secondary Resistance And Polarity... (Voltage Leakage Unit)

a. Adjust engine speed to 1500 RPM and set selector switch to SECONDARY RESISTANCE position.

b. Ground RED test lead.

c. Touch BLACK test lead to each spark plug terminal in turn, observing readings on SECONDARY RESISTANCE scale of tester.

NOTE: REVERSE POLARITY INDICATED BY METER READING OFF-SCALE TO THE LEFT.

18 Ignition Test . . . (Voltage Leakage Unit)

a. Set selector switch in IGNITION TEST position. Connect test leads, one to each coil primary terminal. (Observe polarity)

b. Adjust engine speed to 1000 RPM for Ford V-8, Mercury V-8, and Lincoln.

c. Adjust calibrator to proper SET LINE.

d. Using insulated pliers, lift off any one spark plug wire and note reading on IGNITION TEST scale of meter. Reconnect wire.

NOTE: REPEAT STEP "d." AT EACH SPARK PLUG.

e. Place GFC control in DIRECT position.

f. Move Selector Switch to system voltage position.

g. Connect test leads to insulated battery post and to ground, observing polarity.

19 Fuel Pump Pressure And Volume . . . (Fuel Pump Tester)

a. Set RPM selector to 1000 position.

b. Adjust engine speed to approximately 500 RPM unless otherwise specified.

c. Observe pressure gauge and note fuel pump pressure.

d. Insert volume test hose into graduated container and open clamp.

e. Observe time required for pump to deliver 1 pint of fuel.

20 Idle Mixture . . . (Combustion Vacuum Unit)

a. Connect one end of hose to exhaust condenser and other end to fitting marked EXHAUST on Combustion Vacuum Unit and adjust COMBUSTION REGULATOR knob until meter pointer reads on SET LINE (80%).

b. Insert metal pickup hose in tail pipe of vehicle.

NOTE: WITH DUAL EXHAUST, USE SIDE OPPOSITE MANIFOLD HEAT CONTROL VALVE.

c. Adjust engine speed to specified idle RPM.

d. Observe idle RPM, combustion efficiency, and vacuum reading.

21 Manifold Leak . . . (Combustion Vacuum Unit)

a. With engine operating at idle speed, use a squirt can to apply a mixture of engine oil and

kerosene to the carburetor flange gasket and intake manifold gaskets.

b. Observe Combustion Tester meter for any unusual deflections towards the rich side.

22 Carburetor Mixture Curve . . . (Combustion Vacuum Unit)

a. Set RPM selector to 5000 position.

b. Accelerate engine slowly, pausing at intervals of approximately 200 RPM long enough to permit the combustion efficiency meter to stabilize.

c. Observe and note combustion efficiency reading at each step in test sequence.

23 Accelerator Pump . . . (Combustion Vacuum Unit)

a. Set engine speed to 1000 RPM and allow combustion reading to stabilize.

b. Accelerate quickly to approximately half throttle and immediately drop speed back to 1000 RPM.

c. Observe Combustion Meter for the amount of temporary enrichment.

24 Exhaust Restriction . . . (Combustion Vacuum Unit)

a. Gradually accelerate engine from idle to 2000 RPM.

b. Note vacuum gauge reading.

c. Maintain engine speed at 2000 RPM for approximately ten seconds while observing Vacuum Gauge.

25 Air Cleaner . . . (Combustion Vacuum Unit)

a. With engine operating at 2000 RPM, observe Combustion Meter reading with air cleaner in place on carburetor, and observe Combustion Meter reading with air cleaner removed from carburetor.

b. Compare meter readings observed.

26 Charging Voltage . . . (Voltage Leakage Unit)

a. Maintain engine speed at 2000 RPM.

b. Wait until voltmeter pointer stops rising, then read charging voltage.

27 Final Idle Adjustment . . . (Combustion Vacuum Unit)

a. Reduce engine speed to idle.

b. Set RPM switch to 1000 RPM.

c. Adjust carburetor idle mixture for highest, steadiest vacuum.

d. Idle should be smooth with mixture and speed within specifications.

e. Stop engine.

NOTE: UPON COMPLETION OF THE TEST SEQUENCE DISCONNECT TEST LEADS AND HOSES. MAKE SURE ALL ELECTRICAL, FUEL AND VACUUM CONNECTIONS ON VEHICLE ARE SECURE.

IGNITION PRIMARY CIRCUITS

In the majority of 12 Volt ignition systems, a ballast resistor has been added to the Primary Circuit. On some vehicles the resistor is in the form of a separate component connected in the primary circuit, while on other vehicles a specific ohmic value is built in the lead wire itself. The purpose of a resistance unit is two-fold. First, it limits to a safe maximum the primary current flow through the coil and the distributor contact points, thereby protecting the contact points during slow speed operation when they are closed for a longer period of time. Secondly, the resistor protects against excessive build-up of the primary current when the ignition switch is closed with the engine stopped and the contact points closed.

On certain systems, this resistor is removed from the circuit during cranking and the ignition coil is connected directly to the battery, thus maintaining the ignition voltage as high as possible during

cranking. When conducting the Cranking Voltage Test, it is necessary to attach the voltmeter leads to the coil primary terminals to obtain the correct readings. The following diagrams, which illustrate two types of by-pass circuitry in common use, will aid in determining the proper method of voltmeter connections for cranking voltage tests.

With a ballast resistor in the primary circuit between the switch and the coil, a voltmeter reading from the battery terminal of the coil to ground will be less than battery voltage. The drop in voltage is dependent upon the make and model of vehicle, but if the voltage drop is excessive, it can be attributed to either a defective ignition switch or resistor unit. A faulty ignition switch will give erratic voltmeter readings as the switch is repeatedly turned on and off. The condition of a ballast resistor can be determined by using a SUN ohmmeter.

NO BY-PASS CIRCUIT

With ballast resistor located at "A", the voltmeter is connected from the insulated battery post to ground. With resistor located at "B", the voltmeter is connected from the battery terminal of the coil to ground.

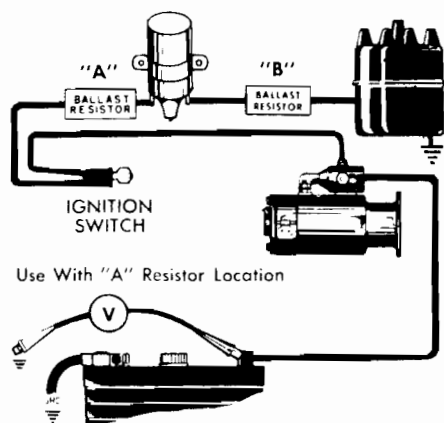
BY-PASS IN SWITCH

Battery voltage is conducted directly from the ignition switch to the coil terminal using a separate lead, thus by-passing the resistor. The voltmeter is connected from the battery terminal of the coil to ground.

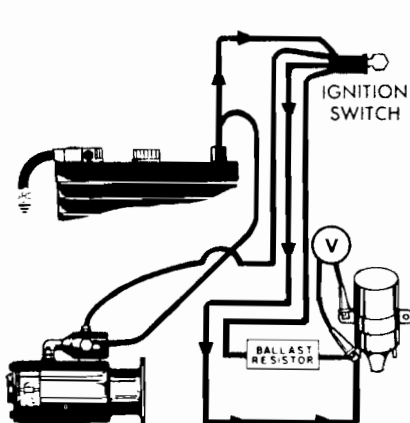
BY-PASS IN SOLENOID

Battery voltage is conducted directly from the solenoid switch to the coil terminal using a separate lead, thus by-passing the resistor. The voltmeter is connected from the battery terminal of the coil to ground.

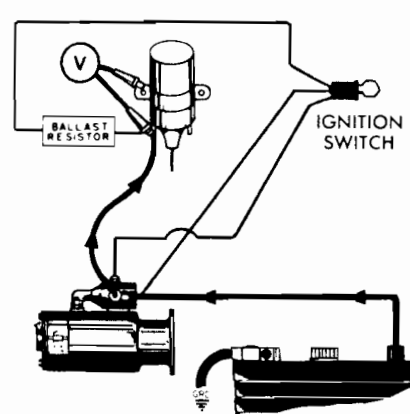
NO BY-PASS CIRCUIT
"A" or "B" RESISTOR LOCATION



BY-PASS IN SWITCH



BY-PASS IN SOLENOID



VOLTAGE LEAKAGE TEST UNIT

MODEL 20

Facilities contained in the Model 20 Test Unit include a four scale Voltmeter with ranges of 4, 10, 20 and 40 Volts; a meter type Ignition Tester; an Electronic Distributor Tester; and a Cylinder Leakage Tester. In this section of the handbook, tests pertaining to each of this tester's facilities will be covered in detail.

It will be noted that when performing tests with the engine in operation, an accurate means of measuring

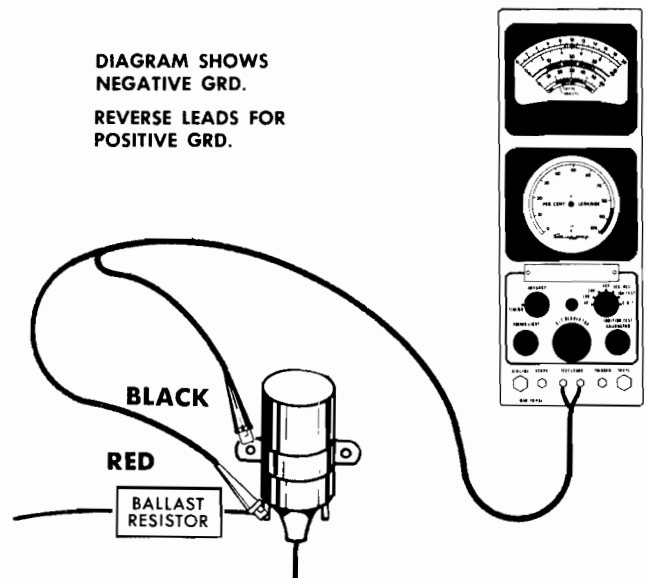
engine speed is required. Therefore, it will be necessary to have a Tachometer connected to the engine as described in the Tach-Dwell Test Unit Section of this Handbook. In addition, to provide a stable voltage input for the ignition system when performing ignition, secondary resistance and polarity tests, it will be necessary to prevent the generator from operating. This can readily be accomplished through the use of a Generator Field control as explained in the Generator Field Control section of this Handbook.

Cranking Voltage Test

This test quickly determines whether or not sufficient voltage is being delivered to the ignition system while the engine is cranking. A normal reading confirms that the general condition of the battery, cables, starting system and the circuit to the ignition system is satisfactory. An unsatisfactory reading indicates that further testing is required in this area.

1. Observing proper polarity, connect tester leads in accordance with the type of primary circuit used on vehicle. (Refer to facing page for details on variations in primary circuits.)
2. Set Selector Switch to:
 - 10 Volt position for 6 volt system
 - 20 Volt position for 12 volt system
 - 40 Volt position for 24 volt system
3. Connect a jumper lead from the distributor primary terminal to ground.
4. With the vehicle's ignition switch "ON", crank engine.
5. Observe cranking voltage, cranking speed and evenness of cranking.

DIAGRAM SHOWS
NEGATIVE GRD.
REVERSE LEADS FOR
POSITIVE GRD.



Results and Indications

Meter reads specified voltage or more, cranking speed normal and even... battery, starter, cables, switch and ignition circuit to coil operating satisfactorily.

Meter reads less than specified voltage... weak battery, defective cables, connections, switch or

starter; defective by-pass circuit or ignition circuit to coil.

Cranking speed below normal... excessive resistance in cables or starting motor, excessive mechanical drag in engine.

Uneven cranking speed... uneven compression, defective starter or starter drive.

Charging Voltage Test

The charging voltage test provides a good over-all indication of voltage available to the vehicle's entire electrical system. The voltage applied to the ignition system is an important factor to be considered in cases of distributor point burning, and when abnormal operating life of other electrical components is encountered.

In cases where abnormal charging voltage readings are encountered, it is suggested that each component in the charging system be tested, utilizing the facilities of a Volts-Ampere Tester, to determine exactly where the malfunction lies within the charging system.

Results and Indications

Charging voltage within specified charging voltage range for vehicle being tested...charging system and voltage regulator operating satisfactorily.

Charging voltage below specified voltage range... defective generator or generator drive, defective

1. Set tester switch to the 10, 20 or 40 Volt position depending on the vehicle's voltage.

2. Observing polarity, connect the tester leads to the insulated post of the battery and to ground, or to the battery post of the regulator unit and to ground, depending upon which is more accessible.

3. With a Tachometer connected, operate engine at a speed of 1500 to 2000 RPM.

4. Note Voltmeter reading after meter pointer stops climbing.

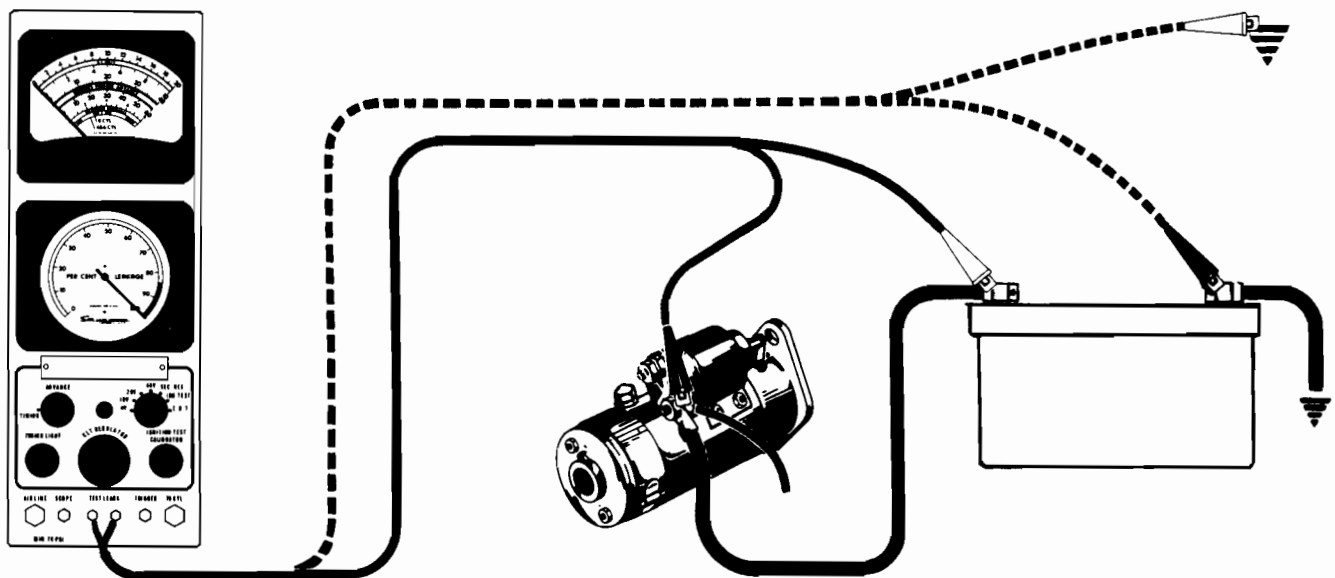
or misadjusted voltage regulator, or high resistance in circuits.

Charging voltage above specified voltage range... defective or misadjusted regulator, high resistance in regulator ground circuit, or defective field circuit.

Battery Cable Tests

Defective or undersized battery cables, loose or corroded connections or excessively long cables can easily be the cause of an inefficient starting system, inefficient charging system, or malfunction in other parts of the vehicle's electrical system. Defective cables and/or connections result in excessive voltage loss (voltage drop) during operation of the cranking motor. The battery should be fully

charged and the starter amperage draw must be within normal limits when conducting battery cable tests. (If any doubt exists concerning the condition of the battery cables or the starting motor, these components should be tested with a Battery Starter Tester.) **IMPORTANT**- Ground the ignition primary circuit at the distributor with the jumper lead to prevent the engine from starting.



INSULATED CABLE TEST

The entire insulated portion of the cranking circuit may be tested in one operation, or each individual portion of the insulated circuit may be tested separately.

1. Set tester switch to the 4 Volt position.
2. Connect one Voltmeter clip to the center of the insulated battery post, and the other to the input

post of the starting motor, observing proper polarity. (Meter will attempt to read battery voltage until starter switch is closed.)

3. Operate starting motor, and observe voltmeter. Generally, on most vehicles, voltmeter reading will not exceed 3/10 of a volt. Refer to specifications.

GROUND CABLE TEST

1. Set tester switch to the 4 Volt position.
2. Connect one voltmeter clip to a ground on the engine block and the other to the center of

the ground post of the battery, observing proper polarity.

3. Crank engine while observing voltmeter. Generally, on most vehicles, voltmeter reading should not exceed 2/10 of a volt.

Results and Indications

Voltmeter readings within specified limits... cables, connections, etc., in normal operating condition.

Voltmeter readings exceed specified limits... defective cable, undersized cable, loose or corroded connections, defective switch contacts, possibility

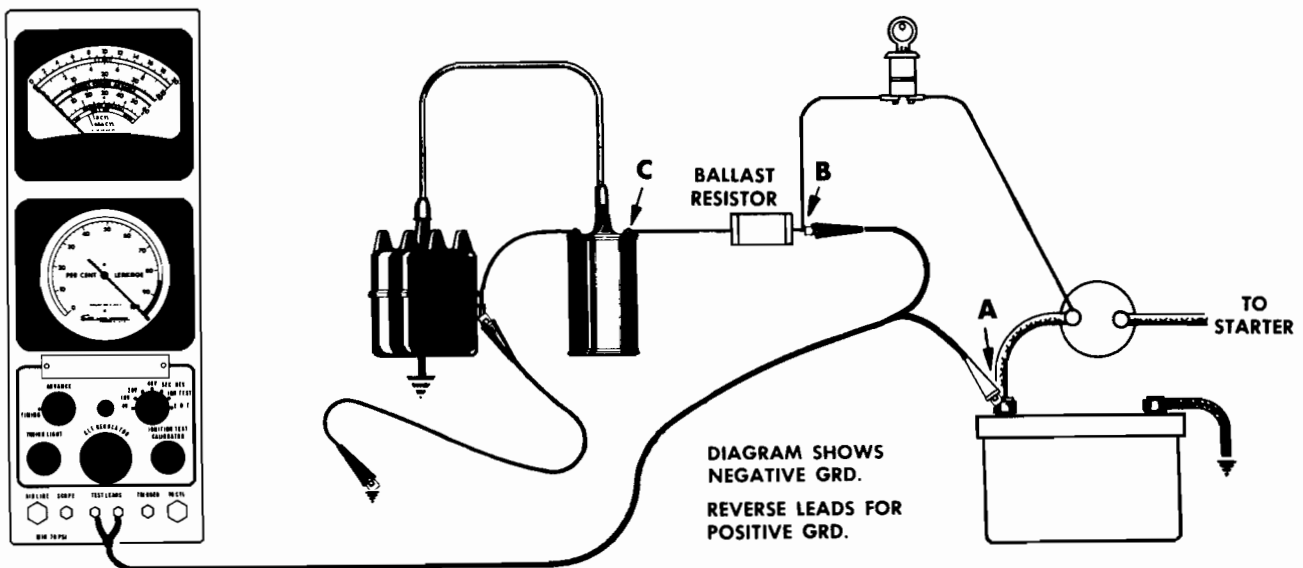
of excessive starter draw, etc.

When excessive voltage drop readings are obtained, retest each item and connection within that portion of the circuit to determine the exact location of fault. Correct the fault by cleaning and tightening connections or replacing cables or components as necessary, then retest.

Ignition Primary Circuit Resistance Test

Excessive voltage loss (voltage drop) in the ignition primary circuit between the vehicle's battery and the ignition coil can reduce the secondary output

of the coil to the extent that hard starting and poor performance can result.



1. Set Voltmeter selector switch to the 4 Volt position.

2. Observing proper polarity, connect voltmeter leads as follows: from "A" to "B" for coils equipped with an external ballast resistor, from "A" to "C" for coils not equipped with an external ballast resistor.

3. Use a jumper lead to ground the primary terminal of the distributor as shown. (Grounding the distributor primary terminal with a jumper lead makes it unnecessary to spot the engine so that the breaker points are closed and also eliminates the possibility of false test readings due to reduced

current caused by defective points, wiring, and connections in the distributor.

4. Be sure all lights and accessories are turned off.

5. Turn ignition switch "ON", and observe voltmeter. Generally voltmeter should not read more than 5/10 Volts.

6. Test ignition switch by turning it "OFF" and "ON" several times. Voltmeter should read the same each time switch is turned on.

7. Test all wires for tightness. Move them about and note any change in meter reading.

Results and Indications

Voltmeter reading within specifications...connections, wiring, switch contacts, etc., in satisfactory condition.

Voltmeter reading exceeds the specified maximum...loose or corroded connections, undersized or faulty wiring, damaged or worn ignition switch contacts, etc.

If voltmeter reading exceeds the specified maximum, isolate the point of high resistance by placing the test leads across each connection and wire in turn. The reading across a connection should be ZERO. The reading across any one wire should be proportionate to its length as compared to the length and allowable voltage drop of the entire circuit.

Primary Circuit Insulation Tests

Defective insulation in the primary system or at the battery, can result in a constant loss of energy from the battery. Trouble of this nature is usually indicated by the battery becoming discharged in

damp weather or when the vehicle is not in use for a day or two at a time. Usually, leakage of this nature is so gradual that it is impossible to detect on the vehicle's charge indicator.

BATTERY LEAKAGE TEST

Electrolyte, dirt, moisture, or foreign material on the surface of the battery cell covers usually result in a continual battery discharge because this foreign material provides a path for battery current to follow. Due to the higher voltages involved, 12 volt batteries are more susceptible to energy losses of this nature than 6 volt batteries.

1. Set tester switch to the 4 Volt position.

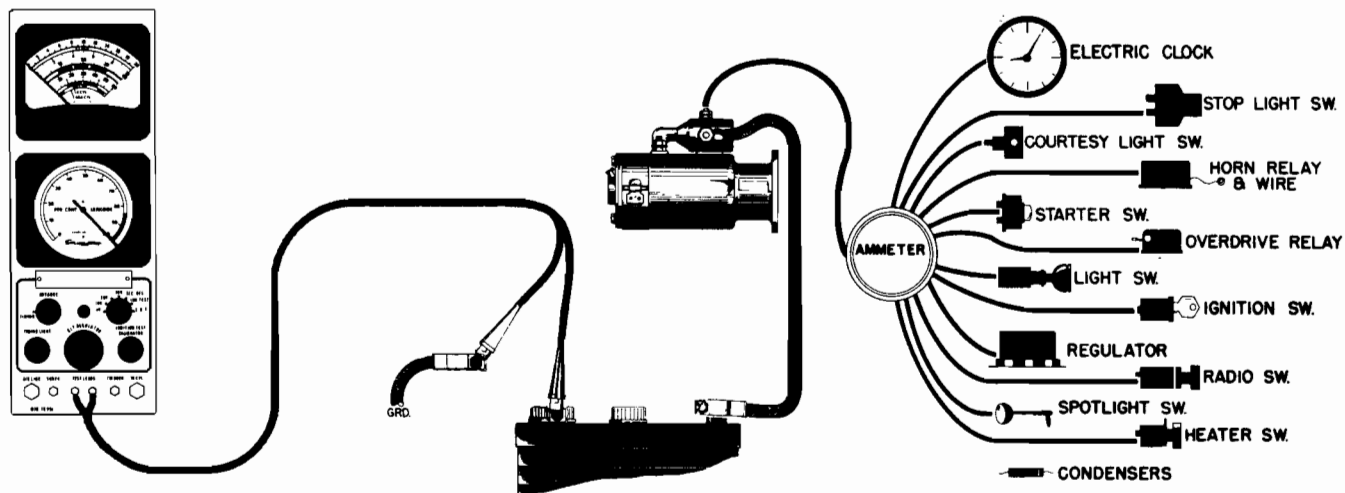
2. Connect the negative voltmeter lead to the negative post of the vehicle's battery.

3. Move the positive voltmeter lead around the surface of the battery, being careful not to touch the cell connecting straps or the positive battery post.

4. Observe voltmeter for indications. Any voltmeter deflection indicates an energy loss due to dirt, moisture, or electrolyte on the external surface of the battery. When this condition exists, it is recommended that the battery be removed from the vehicle, thoroughly cleaned with a solution of baking soda or ammonia and water, and thoroughly dried before reinstallation. It is also suggested that all dirt, moisture, corrosion, etc., be removed from the battery carrier as well as thoroughly cleaning the cable connections. For dependable operation, make sure that the battery is in a full state of charge before reinstallation in the vehicle.

PRIMARY WIRING INSULATION TEST

This test of primary wiring insulation, using a voltmeter, can detect leakage in the insulation too small to be located with an ammeter.



1. Disconnect the ground battery cable from the battery post.

2. Turn off all vehicle switches, and close all doors to prevent operation of courtesy lights from the door switches. Disconnect under hood light if used.

3. Set tester switch to position corresponding to the system voltage of the vehicle.

4. If vehicle is equipped with an electric clock, touch battery cable to battery post just prior to conducting the test to rewind the clock.

5. Observing polarity, connect voltmeter in the circuit; one lead to the battery cable, and one lead to the battery post as shown.

6. Note voltmeter reading.

Results and Indications

Voltmeter reads ZERO... insulation in the vehicles electrical primary circuits normal, no leakage exists.

Voltmeter reads above ZERO... insulation leakage exists in one or more of the vehicle's primary electrical circuits.

To locate leakage (a short) in the primary wiring circuits, remove the battery wire from each of the

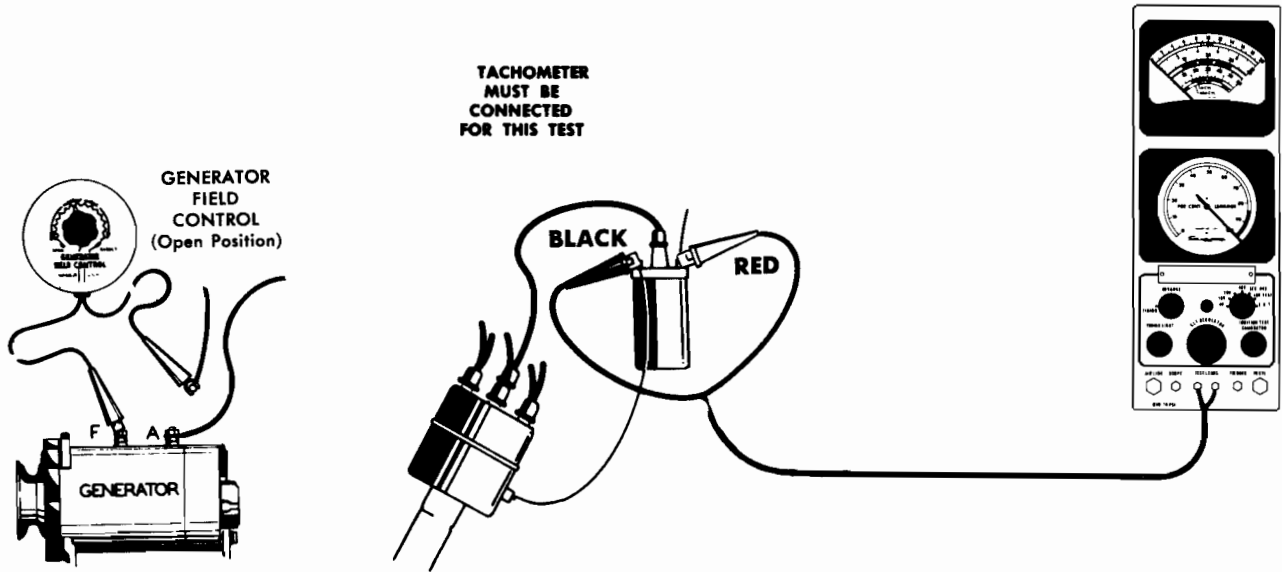
following components in the order in which they are listed. Retest the primary circuit for leaks after disconnecting each item.

Stop light switch, courtesy light switches, horn relay and wire, starter switch, overdrive relay, light switch, ignition switch, regulator, spotlight switch, heater switch, condensers. **NOTE:** Condensers may be located on the light switch, the regulator battery terminal, generator armature terminal, etc.

Ignition Test

Efficient, dependable ignition operation can be expected only when sufficient output is available and secondary insulation is in satisfactory condition. A defect or malfunction anywhere in the ignition system will result in lower than normal ignition output. Defective, cracked or deteriorated

insulation on any component, or in any portion of the ignition secondary circuit, may permit the high voltage impulses from the coil to leak off to ground and thus result in misfire or in overall reduction in the engine's operating efficiency.



1. To prevent the vehicle's generator from operating during the test, connect a Generator Field Control into the generator's field circuit and set the control to its "OPEN" position. (Refer to the Generator Field Control section of this Handbook.)

2. With a Tachometer connected, start engine and adjust speed to 1500 RPM. **NOTE:** For Ford V-8, Lincoln and Mercury, set engine speed to 1000 RPM.

3. Set Selector Switch to IGNITION TEST position.

4. Connect test leads, one to each primary terminal of the vehicle's ignition coil.

5. Adjust the IGNITION TEST CALIBRATOR until the meter reads on the proper set line.

6. Using insulated pliers, remove one spark plug wire from its plug and observe meter reading.

7. For a complete secondary insulation test, note tester reading as each spark plug wire is removed in turn.

Results and Indications

Meter reads in GOOD band when each plug wire is lifted off... both the ignition output and the secondary insulation are satisfactory.

All readings low, or if ignition test calibrator can not be adjusted to set line... high resistance in primary circuit, defective distributor points, defective coil or condenser, coil tower wire, rotor or distributor cap.

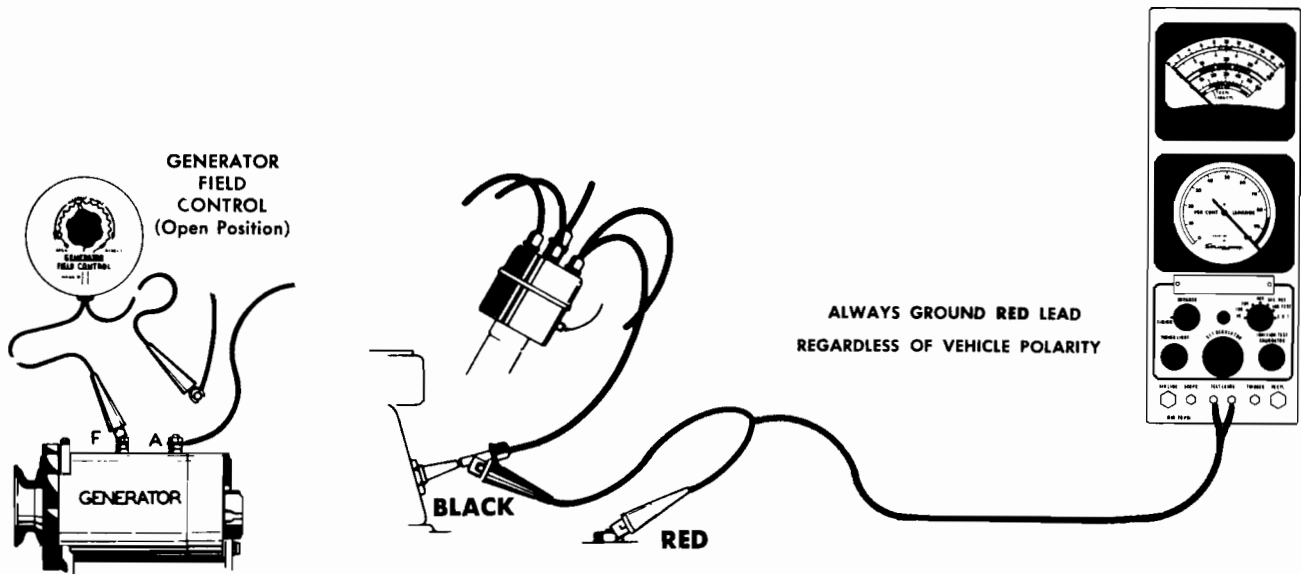
Low readings when only certain plug wires are lifted off... defective insulation on those wires, cracks or carbon tracks in the distributor cap.

NOTE: Errors may be introduced if the coil is not at operating temperature, improper engine speed or ignition test set line is used, distributor point setting is not within specified limits.

Secondary Resistance and Polarity Test

Excessive secondary circuit resistance wastes energy which is needed to maintain good ignition under all conditions, severely reduces ignition system reserve and consequently results in poor performance under severe operating conditions. In-

correct secondary system polarity can result in up to 40% more voltage being required to fire the spark plugs, causing misfire and erratic engine operation.



1. To prevent generator from operating during this test, connect the Generator Field Control into the field circuit of the generator, and set its knob to "OPEN" position. (See Generator Field Control section in this Handbook.)

2. With Tachometer connected, start engine and adjust speed to 1500 RPM.

3. Set Selector Switch to SECONDARY RESISTANCE position.

4. Connect RED test lead to engine ground and contact BLACK test lead to each spark plug terminal in turn. Observe readings on Secondary Resistance scale of meter.

Results and Indications

Meter readings are average for the make and type of circuit being tested...secondary circuit in normal condition.

All readings lower than average for make and type of circuit being tested...corroded coil tower terminal, poorly connected or broken coil wire, center cap electrode burned, burned rotor tip, open secondary in coil.

One or more readings lower than average for make and type of circuit being tested...broken or poorly connected spark plug wires, burned or corroded cap terminals, gouged electrodes inside cap.

Readings higher than average at two or more plugs...cross-fire occurring in the distributor cap or between the spark plug cables concerned.

Meter reads off scale to the left with red test clip grounded...coil secondary polarity reversed; may be due to coil primary wires connected in reverse, wrong coil, or vehicle's battery connections reversed.

NOTE: On vehicles utilizing suppression type ignition cables, readings can be expected to be somewhat uneven with the lowest readings on the longest cables. Although suppression results in lower test readings, normal suppression does not impair ignition efficiency.

Electronic Distributor Tester

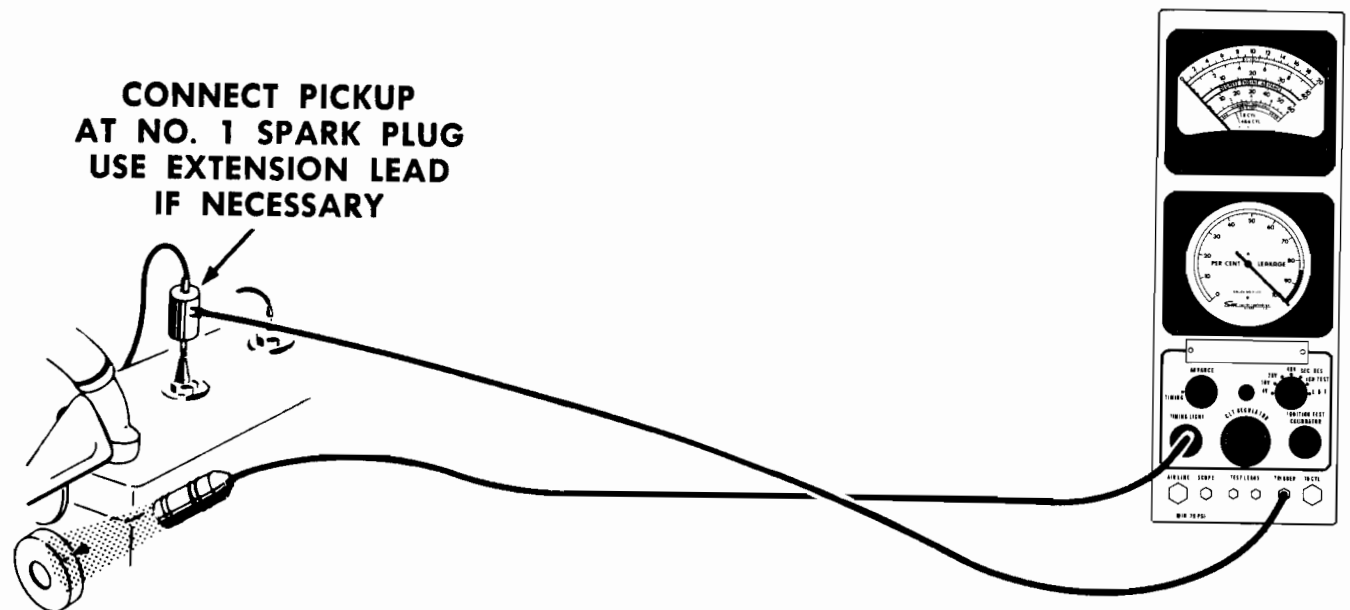
The Electronic Distributor Tester is designed to test ignition timing and ignition advance "on-the-vehicle" with the engine running and will accurately test either conventional or loadomatic type distributors. Should on-the-vehicle tests of the distributor

indicate malfunction of either the mechanical or vacuum advance mechanisms, the distributor should be removed from the vehicle for complete, detailed tests utilizing a Sun Distributor Tester and then serviced as required before reinstallation.

Initial Ignition Timing

Initial ignition timing is a mechanical adjustment establishing the exact point in the engine cycle at which the plug will fire at a specified engine speed. Timing is established and specified by the manufacturer for the exact point in the engine cycle at which the fuel charge should be ignited. The

strobe-light flash of the Electronic Distributor Tester is simultaneous with the firing of the number one spark plug, and when timing is properly set, the specified mark will appear to be aligned with the pointer when the strobe-light flash occurs.



1. Connect trigger pickup into circuit of number one spark plug.

2. Connect a Tachometer to the engine.

3. Turn advance control to **TIMING** position, and set Selector Switch to **EDT** position.

4. Start engine and adjust speed to RPM specified by the manufacturer for initial timing adjustment.

(Disconnect distributor vacuum line if specified.)

5. Use light flash to observe the position of the timing mark in relation to the timing pointer. Refer to manufacturer's specifications.

Results and Indications

Timing mark aligns with pointer at specified speed... ignition properly timed.

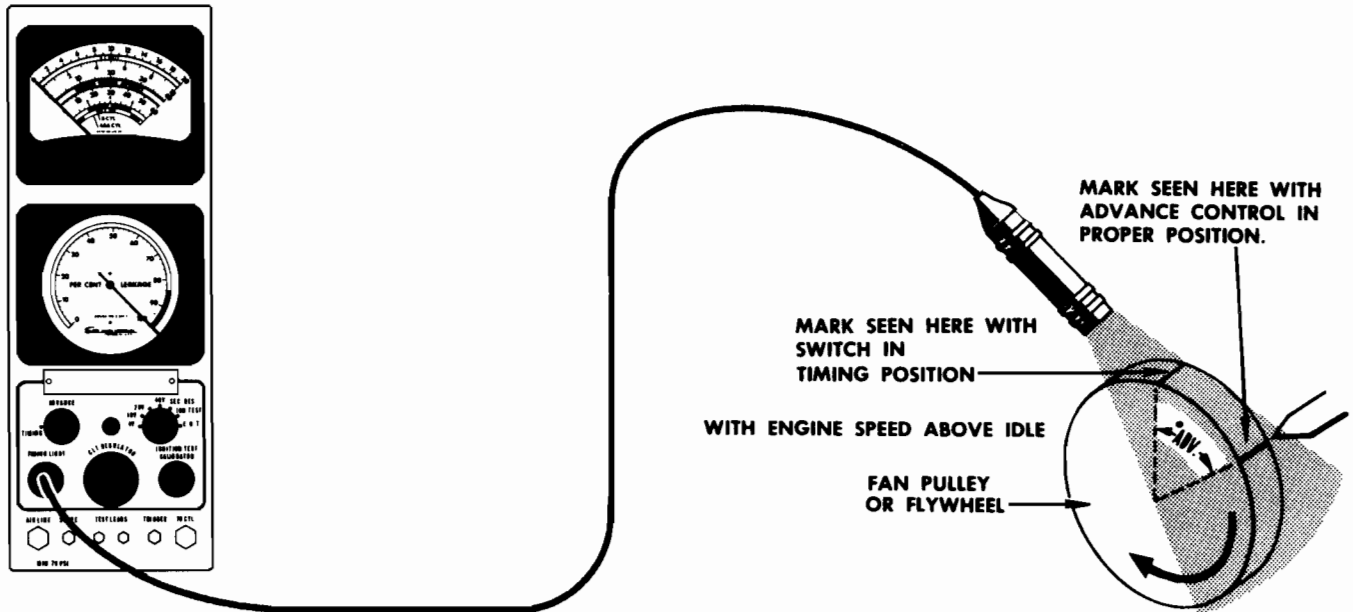
Timing mark not aligned with pointer at idle per manufacturer's specifications... ignition not properly timed.

Position of timing mark not steady... pitted or misaligned breaker points, incorrect breaker point spring tension, worn or loose breaker plate, or worn distributor shaft or bushings.

Distributor Advance Test

Correct timing under all speed and load conditions is extremely important to performance and economy. As engine speed is increased, the distributor advance mechanism causes a spark plug to fire earlier in the engine cycle. As a result, the timing mark moves away from the pointer when viewed with a timing light. Through the use of the Electronic

Distributor Tester, at a specified test speed, the timing mark can be electronically realigned with the timing pointer. When the timing mark is aligned with the pointer as shown in the illustration, the meter will indicate the number of degrees the plug is firing ahead of the initial timing.



1. Reconnect distributor vacuum line if it had been disconnected for the initial timing test. If vehicle is equipped with a loadomatic type distributor, connect a manometer into the distributor vacuum line.

2. Adjust engine speed to 2500 RPM; or until manometer indicates first vacuum specification if vehicle is equipped with a loadomatic type distributor.

3. With strobe light directed at the timing pointer, rotate advance control clockwise until timing mark appears in its original position.

4. Note degrees advance on tester meter, and compare with manufacturer's specifications.

On conventional type distributors, if total advance is incorrect, disconnect distributor vacuum line and repeat test to determine whether vacuum or centrifugal advance mechanism is at fault.

Results and Indications

Total advance readings within range at specified RPM or specified vacuum...mechanical and vacuum advance mechanism or loadomatic vacuum advance mechanism operating satisfactorily.

Total advance readings not within range at specified RPM or specified vacuum...faulty mechanical or vacuum advance mechanism or loadomatic advance mechanism defective.

Distributor Vacuum Leak Test (Applies only to Loadomatic Distributors)

1. With Electronic Distributor Tester, a Tach-Dwell Unit and a Manometer connected as for Distributor Advance Test, adjust engine speed to 1500 RPM.
2. Note exact Manometer reading at 1500 RPM.
3. Pinch the hose closed between the distributor vacuum line and the "T" fitting of the Manometer.
4. Observe Manometer reading and compare with reading obtained in step 2.

Results and Indications

Manometer readings in step 2 and step 4 above, alike and within normal range for type and make of vehicle tested...carburetor and distributor vacuum system airtight.

Manometer reading increases when hose is pinched...defective distributor advance mechanism unit, line or fittings.

Manometer reading does not increase when hose is pinched and distributor vacuum is noticeably lower than that obtained on similarly equipped vehicles at comparable speeds...possible air leaks around carburetor gaskets or a faulty carburetor vacuum system.

Adjusting Initial Timing

When using the Electronic Distributor Tester, there are two methods of adjusting initial timing on an engine. The method to use depends upon timing requirements given by the engine manufacturer.

A. If the engine manufacturer instructs that the ignition timing be adjusted so that the timing mark lines up with the ignition pointer turn the Advance control of the tester to its TIMING POSITION and use the timing light in the conventional manner.

B. If the engine manufacturer instructs that the ignition timing be adjusted so that the TDC mark is advanced a certain number of degrees from the pointer, proceed as follows:

1. Connect the Electronic Distributor Tester as indicated under Initial Ignition Timing.
2. Adjust engine to specified timing speed.

3. Turn tester Advance control until meter reads specified number of engine degrees to which the initial timing is to be adjusted.

4. Loosen the distributor locking screw or bolt and rotate the distributor until the TDC mark aligns with the timing pointer as seen with a Timing Light. Retighten the distributor.

5. Observe meter reading. If readjusting timing changed the meter reading (because of a change in engine speed) repeat steps 3 and 4.

6. Turn the Advance control back to the timing position and observe that the TDC mark is displaced from the pointer. The displacement is equal to the number of degrees that were indicated on the meter in step 3.

Cylinder Leakage Test

In the modern automotive engine, improved designs and higher compression ratios are providing greater power, performance, and economy; but the valves, rings and cylinder heads are being subjected to greater combustion pressures than ever before. These advances in engine design have increased the need for better and more accurate means of testing cylinder leakage.

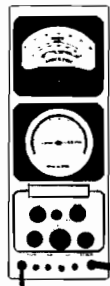
The Cylinder Leakage test will point out exhaust and intake valve leaks, leaks between cylinders or into the water jacket, or any other causes of compression loss. This tester applies air to the cylinder at controlled volume and pressure and measures the percentage of air leakage. Even the smallest

cylinder leak can easily be detected.

Satisfactory engine performance depends first of all upon a mechanically sound engine. In many cases unsatisfactory performance and rough idle are caused by combustion chamber leakage. Experience and research have established that a compression test alone may not show up this fault.

It is normal for a small amount of air to escape past the rings into the crankcase. However, any leak through an intake valve, an exhaust valve, head gasket, head, block or excessive leakage past the rings indicates trouble which must be corrected before satisfactory engine performance can be expected.

HERE'S HOW IT WORKS



TO SHOP
AIR SUPPLY

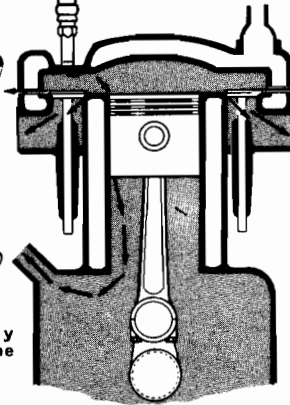
Listen at the air intake
for the hiss indicating
a leak past the in-
take valve.

Piston ring and blow-by
troubles can be heard at the
oil filler or breather pipe.
This one sure pays off.

Here's the equipment to
PIN POINT those elusive
engine troubles-those slight
misses - that loss of power -
those things that make you
scratch your head!

Look outside the block
for a gasket leak with
the air pressure on.
Listen at the radi-
ator, with cap off,
for gasket leak to
water jacket. High
percentage of leak-
age at two adjacent
cylinders points to a
blown head gasket.

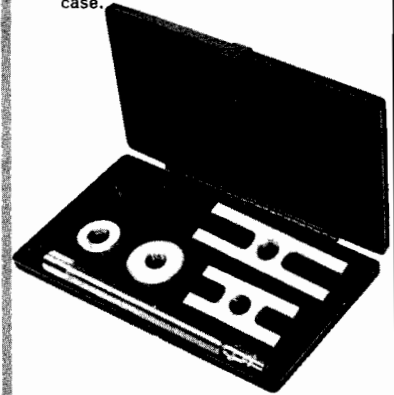
Put your ear
down at the tail
pipe and listen
for that air leak
past the exhaust
valve.



UNIVERSAL DIESEL ADAPTER KIT

Model DAK

For getting the true facts con-
cerning the cylinder, piston ring
and valve condition of diesel
engines this set of universal
adapters may be used with any
Sun Cylinder Leakage Tester.
Adapters included are compati-
ble to practically all motive type
diesel engines. All fittings and
adapters are conveniently con-
tained in a sturdy, formed steel
case.



PREPARATION OF ENGINE

1. Run engine until normal operating temperature is reached.
2. Stop engine, loosen all spark plugs approximately one turn to break free any accumulated carbon adjacent to the spark plugs.
3. Start engine and accelerate to approximately 1000 RPM, to blow out the loosened carbon.
4. Stop engine and remove any foreign matter from around the spark plugs with compressed air.
5. Remove all spark plugs, and gaskets or tubes if used.
6. Remove air cleaner and set carburetor throttle valve to wide open position.
7. Remove crank case filler cap.
8. Remove radiator filler cap. If coolant level is low, fill to prescribed level.

TESTER CALIBRATION

1. Turn CLT Regulator knob counter-clockwise until it turns freely.
2. Connect shop air supply to tester "AIRLINE" fitting. (Minimum 70, Maximum 200 PSI.)
3. Turn CLT Regulator knob clockwise until gauge reads ZERO.

PROCEDURE

NOTE: For testing cylinder leakage of diesel engine, a kit of DIESEL ADAPTERS is available from the Sun Electric Corporation.

1. Select the proper adapter and install in the spark plug hole of number one cylinder. Attach whistle to adapter in the cylinder.
2. Rotate engine until whistle sounds. Continue to rotate engine slowly until engine timing mark (TDC) aligns with engine timing pointer. Remove whistle from the adapter.
3. Remove distributor cap from distributor and connect coil secondary lead to ground.

4. Mount "TDC" indicator on distributor shaft or rotor and chalk mark a suitable reference point on an adjacent surface of the engine which aligns with an applicable mark on the "TDC" indicator.

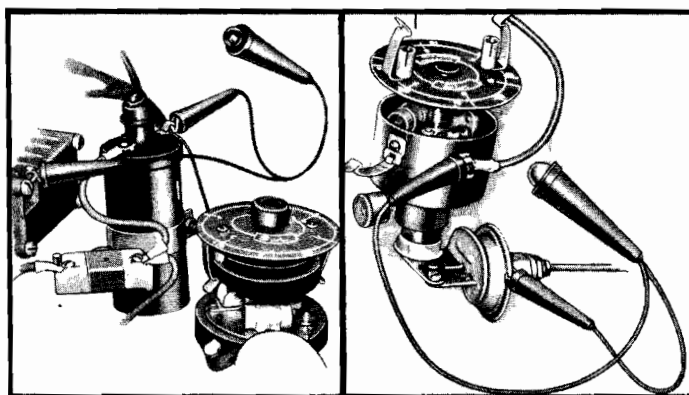
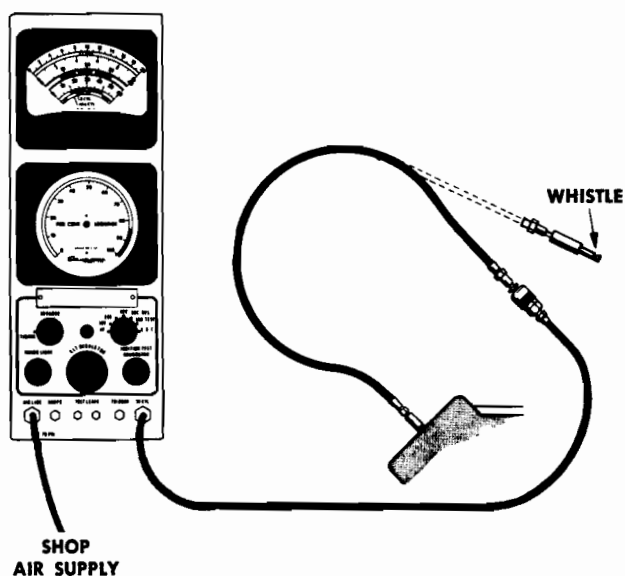
5. Connect the "Indicator Light"; one lead to the distributor primary terminal, other lead to ground. Turn vehicles ignition switch "ON".

6. Connect tester hose to adapter and note the percentage of leakage on the tester gauge. Listen for escaping air through the carburetor, the exhaust or tail pipe, and the crankcase filler pipe. Check for air bubbles in the radiator.

7. Disconnect tester hose from adapter and rotate engine until the next applicable mark on the "TDC" indicator is aligned with the chalk mark on the engine. **NOTE:** Indicator light will glow when piston is in firing position.

8. Remove the adapter from the cylinder previously tested and install it in the next cylinder in the engine's firing order. (Piston in this cylinder is now at top dead center.)

9. Repeat steps 6, 7, and 8 until all cylinders have been tested.



TYPICAL APPLICATIONS OF THE
TOP DEAD CENTER INDICATOR

Results and Indications

Gauge readings comparatively even and less than 20%...engine mechanically sound. (It should be noted that on certain makes and models, readings as high as 20% indicate excessive leakage.)

Air escaping through carburetor...intake valve leaking.

Air escaping through exhaust pipe...exhaust valve leaking.

High per cent of leakage on adjacent cylinders...leaking head gasket, crack in block or head.

Air escaping through radiator...leaking head gasket, crack in block or head.

High per cent of leakage into crank case...worn rings or cylinder walls, stuck, or broken rings, or cracked piston.

NOTE: Analysis of ring and cylinder wall conditions should be made with consideration to case history and mileage of the engine.

Occasionally, in cases where high percentage of leakage is noted on engines with comparative low mileage which could be contributed to stuck rings, it is advisable to treat the engine with a good grade of tune-up or break-in oil for a period of time and then retest before recommending that the engine be disassembled for major servicing.

TACH-DWELL TEST UNIT

MODEL 40

The Tach-Dwell is a basic test instrument providing facilities useful in practically all types of engine tune-up operations, vehicle tests, charging system tests and fuel system tests, since most of these tests are made at specified speeds. In addition to measuring speed, this tester also provides

Calibration

Both needle pointers should read on zero when the tester switch is OFF. To zero the meters, turn the zero corrector buttons located on the front of the meters. Once adjusted, this adjustment will not change...unless jarred or otherwise disturbed.

Distributor Resistance Test

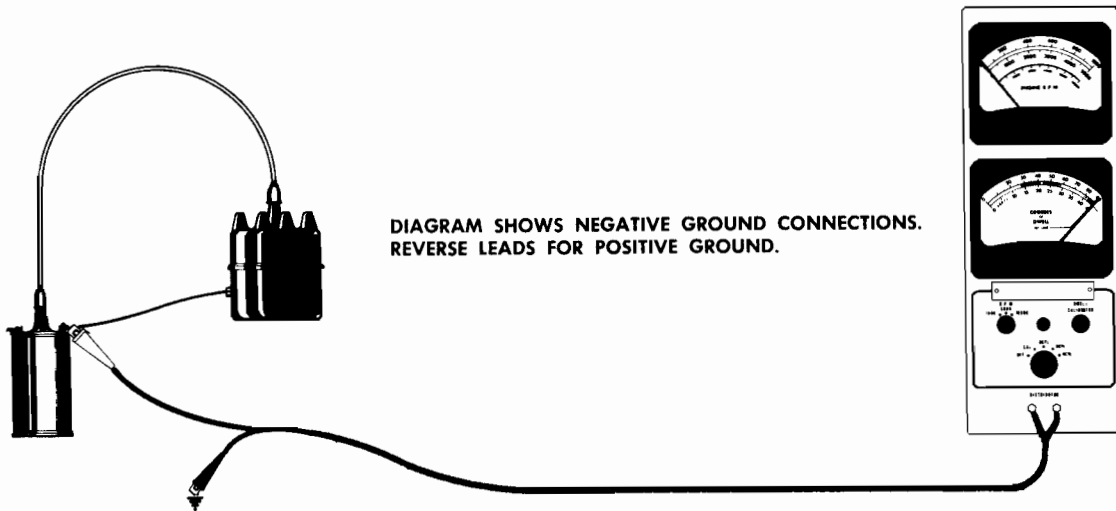
Excessive resistance in the ignition primary circuit from the distributor side of the coil, through the points, and to the distributor ground will prevent the coil from producing sufficient output for good over-

facilities for measuring point dwell and performing other important ignition tests. Since the facilities of this tester are used with so many different vehicle tests, and it is used so frequently in most shops, its applications and operating procedure should be thoroughly understood.

1. With the test leads disconnected from vehicle, set tester switch to calibrate position.

2. Adjust the dwell calibrator until the dwell meter pointer reads on the set line.

all ignition. Any resistance in this portion of the ignition system will be indicated on the dwell meter during this test.



1. Observing proper polarity connect test leads, one to the distributor primary lead at the coil and the other lead to ground.

2. Turn vehicle's ignition switch ON.

3. With engine stopped, observe dwell meter.

If meter reads zero, crank the engine a fraction of a revolution to close the breaker points.

Results and Indications

Dwell meter pointer reads within range of black bar...distributor resistance is within normal tolerances.

Dwell meter not within black bar... high resistance at internal distributor connections, external distributor connections, contact points, distributor mounting.

To locate excessive resistance, trace the primary circuit by moving the tester lead step by step through the distributor toward the ground lead.

All excessive resistance must be eliminated before proceeding with the dwell, dwell variation and other ignition tests.

Dwell

Dwell is the period during which the distributor points remain closed for each ignition cycle. The dwell meter electrically measures this period and registers the average for each cylinder in terms of degrees of distributor cam rotation.

The total number of degrees for each ignition cycle is 360 degrees divided by the number of cylinders. The illustration for a 6 cylinder engine shows 60 degrees (between dotted lines) for each cylinder, and 36 degrees (the shaded area) as the dwell. A study of this illustration shows that a wider point setting will result in less dwell and a closer point setting will increase the dwell.

1. Calibrate the tester, and connect to the engine as for distributor resistance test.

2. Set the tester's Selector Switch to the position which corresponds to the number of cylinders in the engine being tested.

3. Operate engine at idle speed and note reading on dwell meter. Dwell of 6 and 8 cylinder engines is read on the 0-45 degree scale, while the dwell of 4 cylinder is read on the 0-90 degree scale.

Results and Indications

The dwell reading within specified tolerances... ignition points are operating normally and are spaced properly.

Dwell Variation

Dwell variation is determined by noting any dwell change as the engine is operated at different speeds. Excessive variation indicates a change in point opening that can result from shaft or bushing wear, or from the distributor plate shifting because of wear or looseness.

1. Measure distributor dwell at idle speed.

Results and Indications

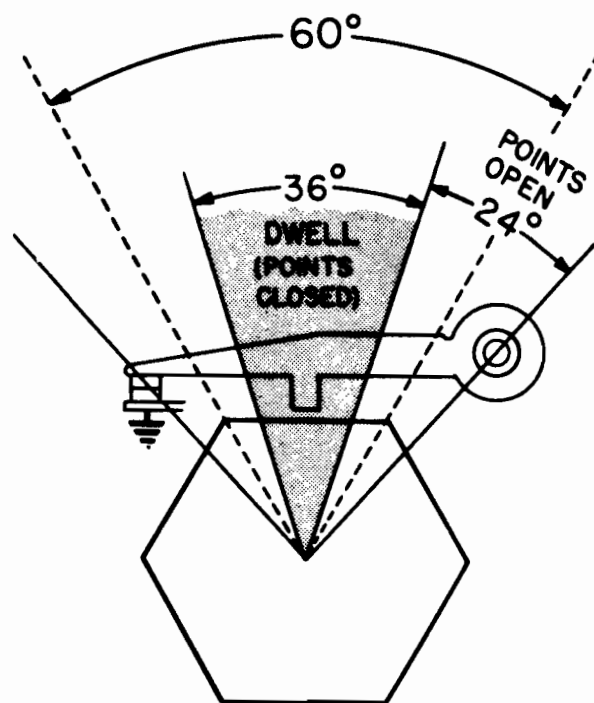
Dwell variation within manufacturer's specified tolerances... distributor is in sound mechanical condition.

Measuring Engine Speed

Ignition, combustion efficiency, and other tests covered elsewhere in this handbook call for specific engine speeds in order to obtain correct indications. Therefore, during these tests, the Tach-Dwell unit must be connected to the vehicle.

1. Connect leads of tach-dwell unit to vehicle as illustrated, observing proper polarity.

2. With Selector Switch set in proper cylinder position;



Dwell reading not within specifications... improper point spacing, wrong point assembly, point rubbing block defective, point rubbing block misaligned, worn distributor cam.

2. Set Tachometer switch to the 5000 RPM position, and increase speed to 1500 RPM.

3. Note dwell reading at 1500 RPM, then slowly reduce speed to idle while watching dwell meter. Dwell reading should not change more than 3 degrees on most vehicles. Refer to vehicle specifications before condemning distributor.

Dwell variation exceeds manufacturer's maximum specifications... worn distributor shaft, loose distributor shaft, worn bushings, worn breaker plate.

- a. Set Tachometer switch to 1000 RPM position, for all idle and low speed testing. Each graduation in the 1000 RPM represents 20 RPM.

- b. Set Tachometer switch to the 5000 RPM position when testing at speeds between 1000 and 5000 RPM. Each graduation in the 5000 RPM scale represents 100 RPM.

- c. Set Tachometer switch to the 10,000 RPM position for measuring engine speeds in excess of 5000 RPM. Each graduation in the 10,000 RPM scale represents 200 RPM.

SUN SCOPE

The Sun Scope provides a convenient means of observing an ignition system's performance by displaying an easily interpreted graph-like picture of all phases of ignition cycle the instant at which these occur on an operating engine. The picture thus displayed permits the observer to actually see in minute detail the results of a multitude of factors effecting the ignition system's operation. The factors which once were assumed in theory only, such as firing voltage requirements, spark duration, coil and condenser action, breaker point action and maximum ignition system voltage output, can now be accurately seen.

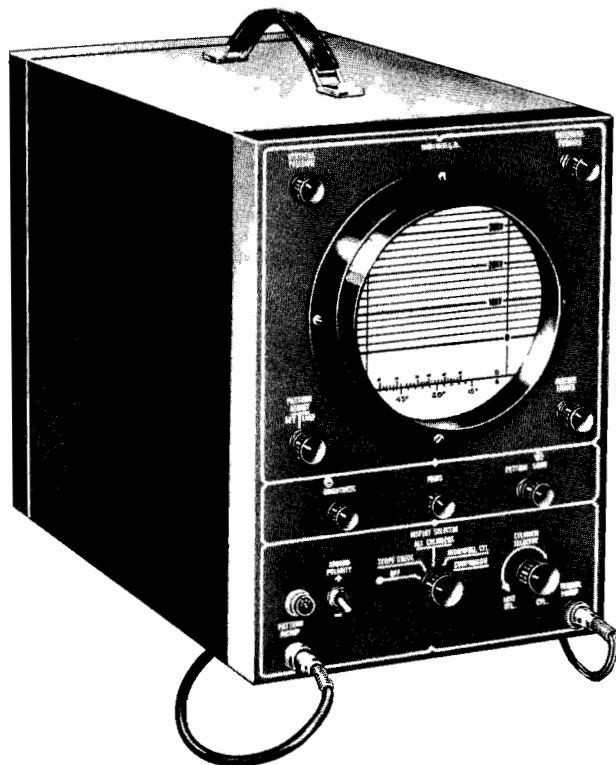
Testing with the Sun Scope is comparatively simple. Aside from one or two physical operations involved, actual testing consists of observing the pictures or patterns for irregularity. Since each part of the pattern represents certain events which occur in the various parts of the ignition system, any deviations from the normal appearing patterns will quickly indicate the types of troubles present. The Sun Scope is designed to permit an operator to view the patterns of all cylinders side by side in the engine's firing order, each cylinder's pattern in turn individually, a choice of patterns compared one above the other, or a superimposed display of all cylinders' patterns.

To interpret Sun Scope test results, it is important that the basic Oscilloscope Wave Form Pattern be thoroughly understood. Review and study the following two pages very carefully. Before applying the Sun Scope to an engine, it is suggested that the operator become familiar with each Scope control and its function, and the Scope's connections to the vehicle.

In the interest of speed, ease and over-all ignition testing, a nine-step condensed test procedure is outlined in this section of the Handbook. For a more detailed analysis and to help in pin-pointing ignition troubles, several auxiliary tests are described in the latter portion of this section. To aid in interpreting the variations of the basic wave form pattern, the Scope Test Indication section illustrates and describes the scope patterns representing many of the more commonly encountered ignition troubles.

To quickly associate Scope indications of ignition troubles with a specific cylinder or cylinders of the engine, the operator should be familiar with cylinder numbering arrangements and engine firing orders. The last page of this section illustrates and lists engine cylinder arrangements and firing orders usually encountered on American built passenger cars.

Certain ignition system functions vary with the input voltage available to the ignition coil. Therefore, to be assured of obtaining accurate test results, it is necessary to prevent the generator from operating during the ignition test sequence. A convenient means of preventing the generator from operating, regardless of whether the vehicle is equipped with an AC or a DC system, is to connect a Sun Generator Field Control into the generator's field circuit, and to position the control knob in its "open" position.



EXPLANATION OF SCOPE PATTERNS

Before applying the Sun Scope to an engine, it is suggested that the operator become familiar with the Scope controls and their function, and the Scope connections to the engine.

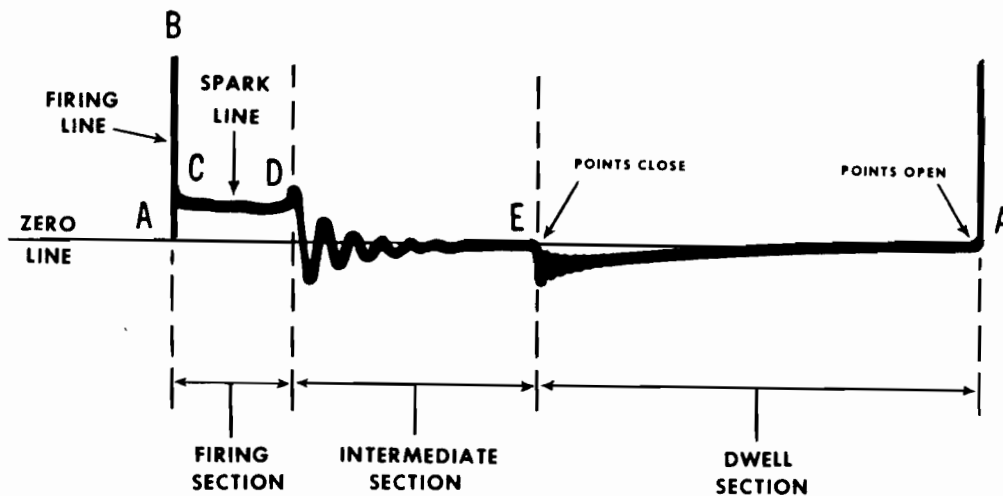
To interpret Scope test results, it is important that the basic oscilloscope waveform or pattern be thoroughly understood. Study the following carefully.

The display (or trace) visible on an oscilloscope screen is usually referred to as a pattern or waveform. In studying oscilloscope patterns, consider them to be graphs of voltage with respect to time. The vertical displacement from the ZERO line (either up or down depending on polarity) represents voltage at any instant along the ZERO line.

The Sun Scope is designed to display either a Second-

ary waveform which is obtained at the coil's high tension tower, or a Primary waveform which is obtained at the distributor primary terminal of the coil. However, because the Secondary waveform is generally the most informative for showing over-all ignition system operation, the screen of the Sun Scope is laid out in kilovolts (KV) to permit accurate voltage measurements of Secondary patterns to be made. Each vertical division of the screen represents 2 kilovolts (2000 volts), providing the Scope's Pattern Height control is positioned at its SET LINE.

Each part of the waveform represents a specific phase of ignition system operation. For the purpose of understanding and analyzing the Scope pattern, it is divided into three sections; The Firing Section, the Intermediate Section and the Dwell Section.



BASIC PATTERN SECTIONS

The Firing Section

So called, because it is during this period that the actual firing of the spark plug takes place. This section of the pattern is composed of only two lines:

The Firing Line, a vertical line indicating the voltage required to overcome the plug and rotor gaps.

The Spark Line, a horizontal line indicating the voltage required to maintain the spark.

Point "A" in the pattern illustrated represents the

instant at which the breaker points have separated. The resulting high voltage is indicated by the vertical rise from "A" to "B" in the pattern. The height at point "B" shows the voltage required to fire the plug and rotor gap; sometimes referred to as the "firing" or "ionization" voltage.

Once the plug fires there is a noticeable drop in secondary voltage to point "C". As the spark continues to bridge the gap, the spark voltage remains at a fairly constant low value until the spark extinguishes at point "D".

The Intermediate Section

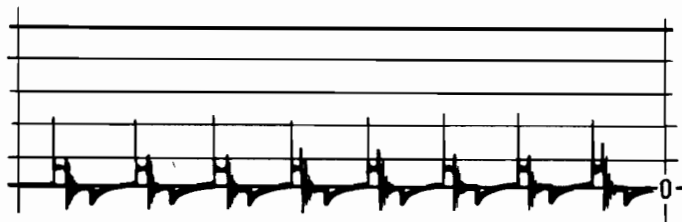
This section, which immediately follows the Firing Section, is seen as a series of gradually diminishing oscillations which disappear or nearly disappear by the time the Dwell Section begins. Beginning at point "D", the remaining coil energy dissipates itself

as an oscillating current which gradually dies out as it approaches point "E". The oscillation results from the combined effects of the coil and the condenser in dissipating this energy.

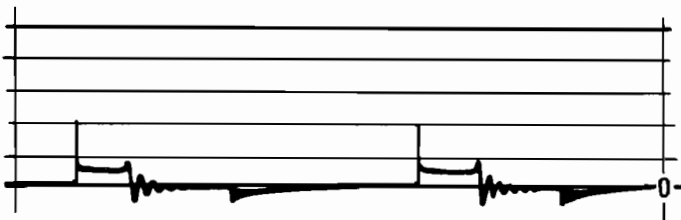
The Dwell Section

This section represents the period of time during the ignition cycle in which the breaker points are closed. The Dwell Section begins at point "E" when the breaker points close. Closing the points causes a short down-

ward line followed by a series of small rapidly diminishing oscillations. The Dwell Section continues until the points open at the beginning of the next waveform (the next point "A").



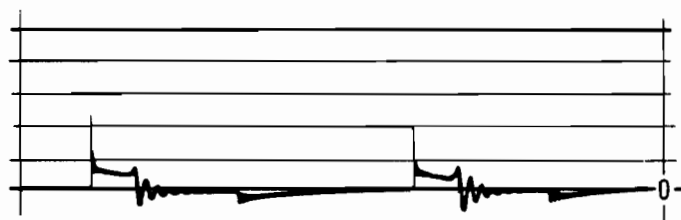
A-1



A-2



A-3



A-4

Figure "A-1" represents an ALL CYLINDER Sun Scope display of an eight cylinder ignition system which contains no suppression and is functioning in a normal manner. Figure "A-2" illustrates the INDIVIDUAL CYLINDER display of the above engine.

The patterns illustrated in Figures "A-3" and "A-4" represent a normally functioning eight cylinder ignition system which incorporates secondary suppression, as they would be observed in the ALL CYLINDER

or INDIVIDUAL CYLINDER Sun Scope display.

To be particularly noted is the slight difference in the length and shape of the sparklines when comparing the above illustrated patterns. It will be observed that the spark lines of the suppressor equipped system begin at a slightly higher voltage than that of the other system and that they slant downward slightly as they approach the Intermediate Section and appear to have slightly more oscillations.

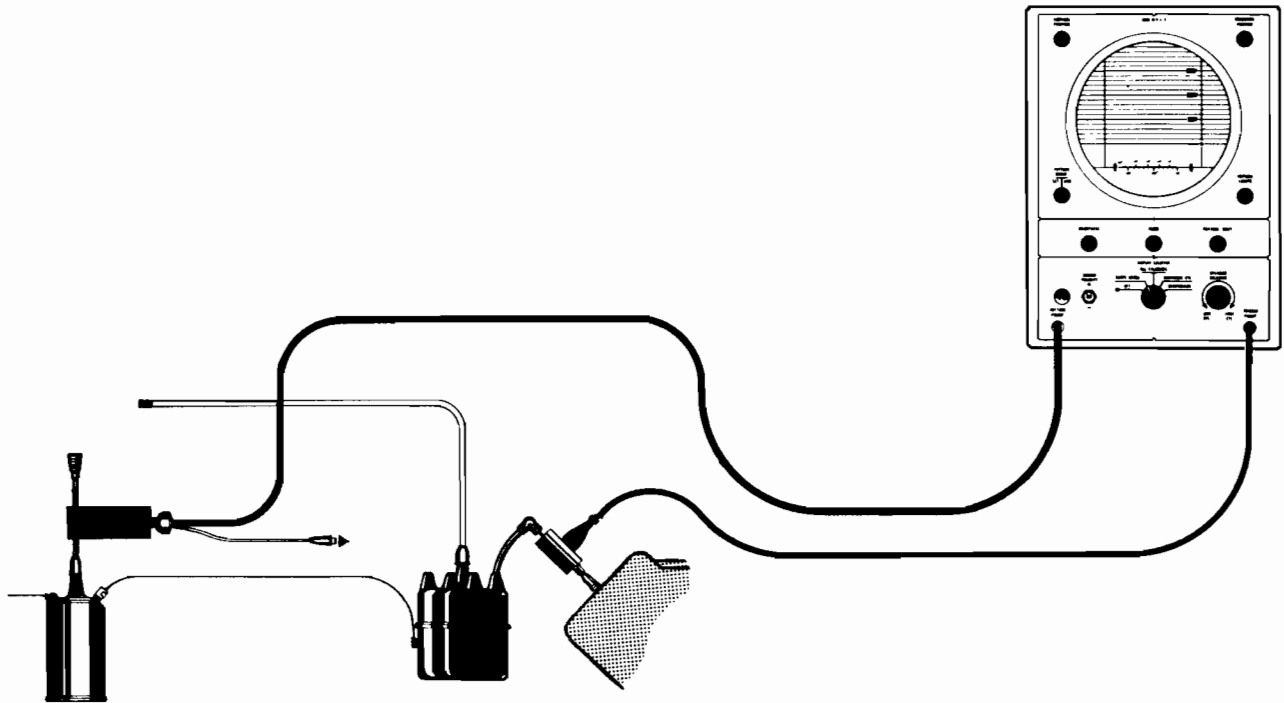
SUNSCOPE TEST PROCEDURE

The following test procedures for use of the secondary and primary pattern pick-ups are to serve mainly as a guide, and can be varied in control settings or sequence to best suit the desires of the operator and the particular test problems encountered. An engine speed of 1200 RPM is recommended for performing most tests. However, when an engine does not perform properly at speeds other than 1200 RPM it is recommended that in addition to testing at 1200 RPM, tests should also be performed at the speed or speeds where the performance difficulty is most prominent. To make comparisons of performance, before and

after services have been completed, it will of course be necessary that the tests be made under the same speed and operating conditions.

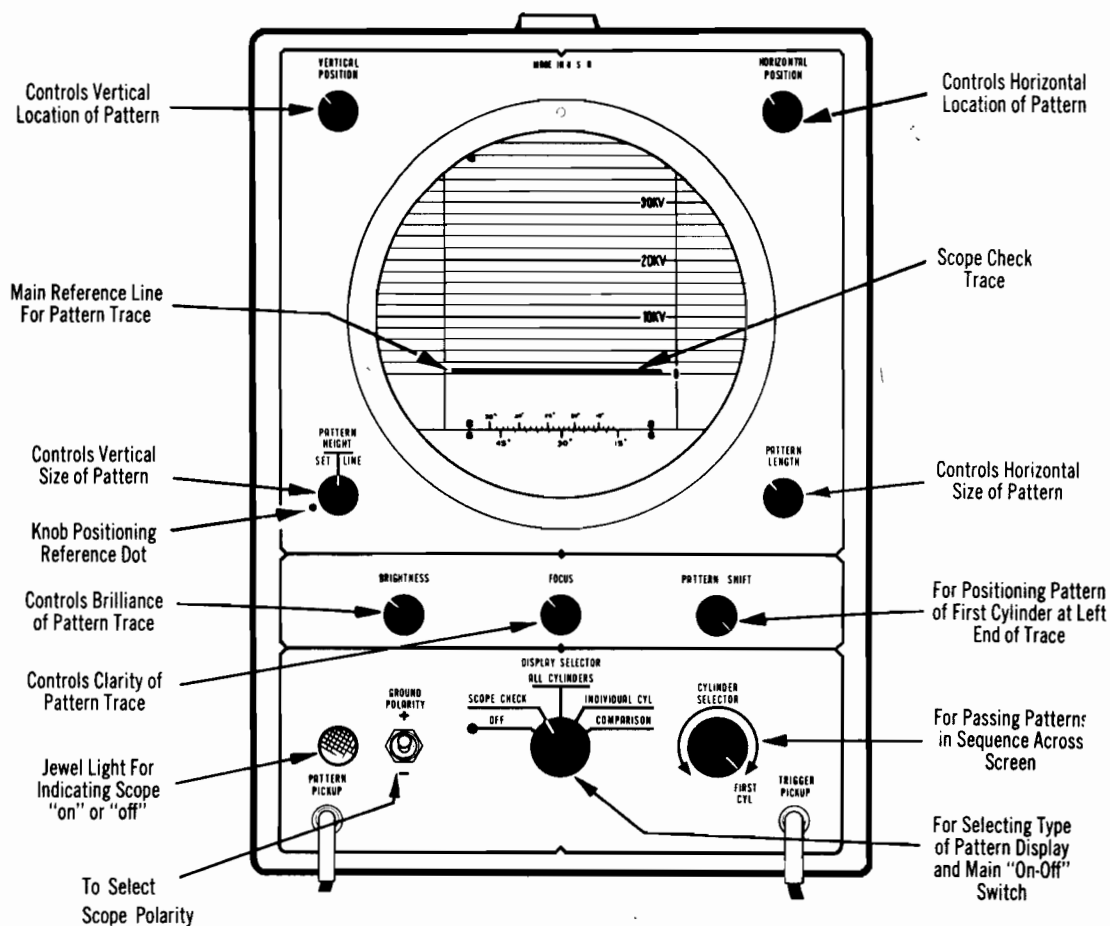
The pattern illustrations associated with each basic step in the test procedure are representative of the average normal system being tested at an engine speed of 1200 RPM. These normal patterns can be expected to vary slightly because of minor variations in engine and ignition system design, number of cylinders, specified dwell settings and the absence or presence of ignition suppression.

CONNECTIONS AND CONTROL SETTINGS



1. Plug Power Lead into an AC outlet of voltage and frequency as indicated on the Tester name-plate. Place Master Switch in ON position.
2. Connect Tach-Dwell Unit as in engine speed testing (RPM switch in 5000 position).
3. Connect Generator Field Control into generator's field circuit, set control to "OPEN" position.
4. Remove high tension wire from coil and leave wire disconnected.
5. Insert Secondary Pattern Pickup into coil tower and attach Ground Clip to a good ground on the engine.
6. Connect Trigger Pickup into the circuit of the first spark plug in the firing order.
7. Turn Display Selector to SCOPE CHECK position, and Ground Polarity Switch to POSITIVE (+) position.
8. With Display Selector in SCOPE CHECK position, a horizontal line (scope trace) will appear on the screen after about 30 seconds warm-up. (If trace does not appear, turn Brightness Control clockwise and rotate Horizontal and Vertical Position controls until trace appears on the screen.)
9. Adjust Horizontal and Vertical Position controls to align left end of trace with vertical line on left of screen at ZERO line.
10. Adjust Brightness and Focus controls to obtain desired brilliance and a sharp clear trace.
11. Rotate Pattern Shift and Cylinder Selector controls to FULL CLOCKWISE position.
12. Adjust Pattern Height control to SET LINE.

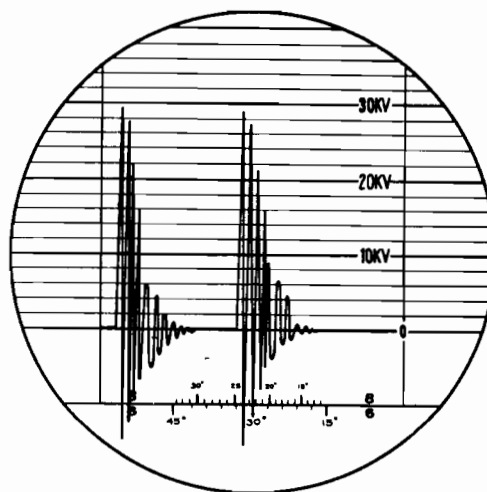
SCOPE CONTROLS



COIL OUTPUT VOLTAGE AT CRANKING SPEED

This is a Scope measurement of the secondary voltage available to fire the spark plug while the engine is being cranked. In instances of hard starting or starting failure, it may quickly confirm or eliminate the primary circuit and coil as the cause.

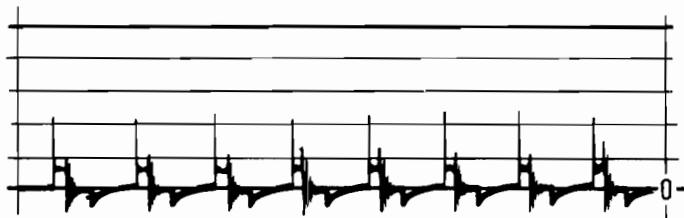
1. With ignition switch ON, crank engine and note coil output voltage. Coil output voltage should extend at least 20 KV above ZERO line.



SECONDARY POLARITY

Incorrect Secondary Polarity can result in up to 40% more voltage being required to fire the spark plugs.

1. Insert high tension coil wire into Pattern Pick-up.
2. Start engine and operate at 1200 RPM.
3. Turn Scope Display Selector to ALL CYLINDERS position.
4. Adjust Pattern Length control until all cylinders appear between the vertical lines on both sides of the screen.
5. Rotate Pattern Shift control counter-clockwise until last pattern on the screen appears complete.



6. Observe patterns. (Reversed secondary polarity is indicated on the Scope as an inverted pattern.)

NOTE: Ground Polarity Switch must be in POSITIVE (+) position, regardless of vehicle's battery polarity.

REQUIRED (firing) VOLTAGE

This is the voltage required to overcome the rotor and plug gaps and to establish a spark across the spark plug electrodes. Condition of the spark plugs and/or secondary circuit, temperature, fuel mixture,

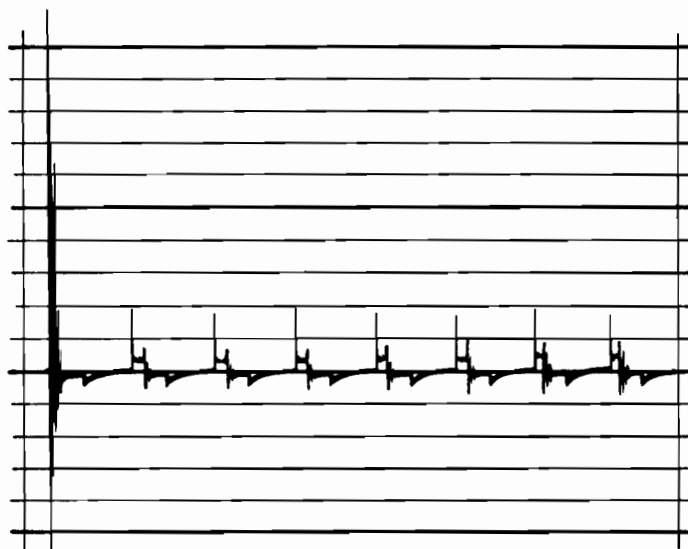
and compression pressures can affect the required voltage.

1. Compare height and uniformity of firing lines. Should be even and 4 to 7 KV.

AVAILABLE VOLTAGE

When a spark plug wire is removed, secondary voltage rises to the highest value of which the system is capable, attempting to jump the gap thus created. Comparing this value to the Required Voltage gives a good indication of "Ignition Reserve." If "Ignition Reserve" is insufficient at test speed, ignition failure can occur when subjected to the more severe requirements of various driving conditions.

1. Use insulated pliers to disconnect a wire from a spark plug. (Hold spark plug wire away from any ground.)
2. Observe pattern. Upward extent of pattern represents Available Voltage in Kilovolts. (Should be at least 20 KV.)



SECONDARY INSULATION

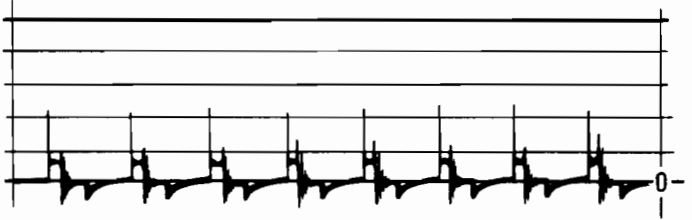
The insulation of all parts of the secondary circuit must be of high quality and in good condition to insure reliable ignition system function under all operating conditions. Should the insulation of one or more secondary components be defective or have deteriorated to some degree, it may have little or no effect on ignition system operation when the firing voltage requirements of the vehicle are moderate. However, when firing voltage requirements are high, this defective insulation may leak or break down, allowing much of the voltage surge to be lost to ground resulting in misfire of one or more plugs.

1. Observe downward extent of pattern of cylinder with spark plug wire removed. (Note length of downward extent and whether it is consistent or intermittent.) Downward extent should equal at least 1/2 of the upward extent.
2. Reconnect wire to spark plug.
3. Test remaining cylinders in the same manner. (Trigger cylinder must be tested in SCOPE CHECK position.)

SECONDARY RESISTANCE

"Spark Line" analysis reveals the condition of the secondary circuit conductors. Excessive resistance uses up energy which is needed to maintain good ignition, and consequently results in poor performance under severe operating conditions.

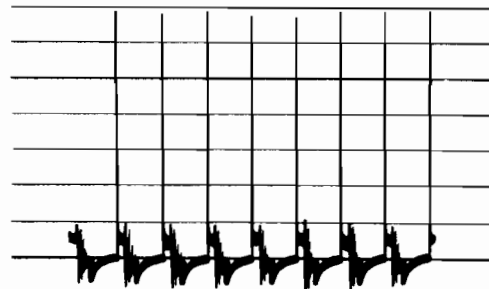
1. With Display Selector in ALL CYLINDERS position, observe and compare spark line of patterns for height, length, angle, and oscillations. For closer examination, the pattern for each cylinder may be expanded, viewed individually, or compared. (Use Pattern Length, Display Selector, and Cylinder Selector controls.)



SPARK PLUGS UNDER LOAD

When a load is applied to an engine the Required Voltage rises. This rise will be slight and uniform if the plugs are in good condition and properly gapped. However, if any unusual firing characteristics are observed while the engine is operating under a load, it generally indicates faulty spark plug condition. To be particularly noted are the individual firing voltages that are considerably higher or lower than the firing requirements of the other cylinders of the engine.

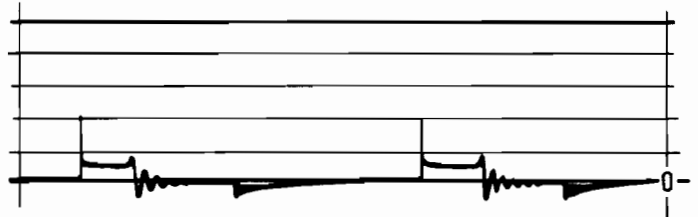
1. With Display Selector set in ALL CYLINDERS position, rotate Pattern Shift control FULL CLOCKWISE.
2. Momentarily accelerate engine (to approximately 2000 RPM) and note rise of the firing lines.
3. Allow engine speed to return to 1200 RPM.



POINT CONDITION AND ACTION

The Scope permits direct observation of point action. Since the points are the main switch in the primary circuit, and are required to make and break this circuit for each spark at the plug, it is essential that every phase of their operation be correct. Arcing, bounce, or poor contact can be quickly detected.

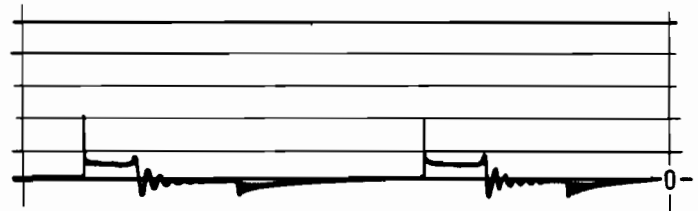
1. Turn Display Selector to the INDIVIDUAL CYLINDER position.
2. Observe POINT CLOSE and POINT OPEN signal for normal operation.



COIL AND CONDENSER

If the coil and condenser are functioning normally, energy remaining in the system after the firing cycle is completed dissipates in diminishing oscillations. The absence of these oscillations is a clear indication of trouble.

1. Observe and note the number of oscillations in the intermediate section of patterns.



SCOPE TEST INDICATIONS

The Test Indications section which follows, illustrates only the more frequently encountered patterns which indicate specific types of troubles as displayed at an engine speed of 1200 RPM. It must be realized that many of the troubles and defects which occur, can exist in various degrees of severity which in turn

will determine how prominently the trouble will be disclosed in the Scope display. Another important fact which must be considered is that occasionally two or more troubles may be present at the same time, and in some instances these troubles may have opposite effects on an ignition waveform pattern.

UNSATISFACTORY TEST RESULTS

PROBABLE CAUSES

COIL OUTPUT VOLTAGE AT CRANKING SPEED

Low secondary voltage →

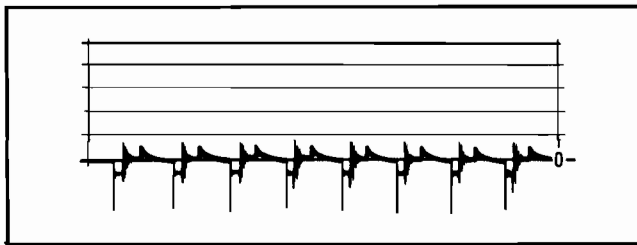
**Battery Low
Defective Ignition Circuit
Failure of Resistor By-Pass Circuit
Insufficient Dwell
Excessive Distributor Resistance
Defective Coil or Condenser**

No oscillations following voltage rise. →

Defective Coil or Condenser

SECONDARY POLARITY

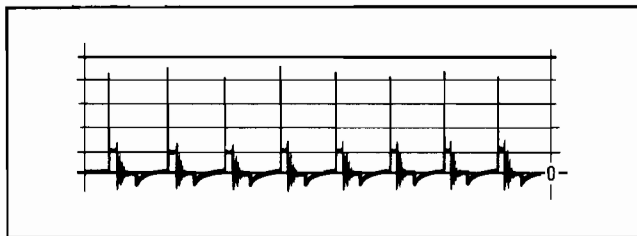
Pattern inverted →



**Scope Polarity Switch in Wrong Position
Battery Polarity Reversed
Coil Improperly Connected
Incorrect Coil for the Vehicle**

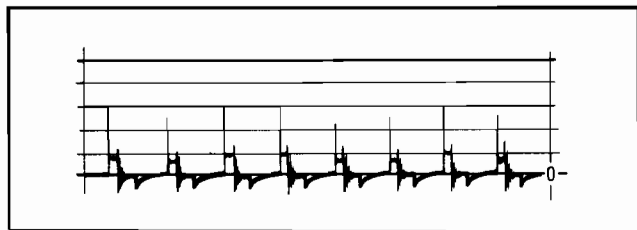
REQUIRED (FIRING) VOLTAGE

Firing voltages uniform—but high →



**Worn Spark Plug Electrodes
Late Ignition Timing
Lean Fuel Mixture
Too Large Rotor Gap
Break in the Coil Wire**

Uneven firing voltages →



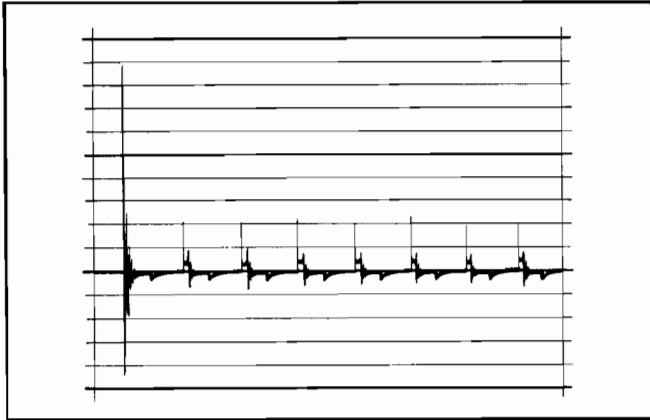
**Worn Spark Plug Electrodes
Unbalanced Fuel Mixture
Breaks in Spark Plug Wires
Cocked or Worn Distributor Cap**

UNSATISFACTORY TEST RESULTS

PROBABLE CAUSES

AVAILABLE VOLTAGE

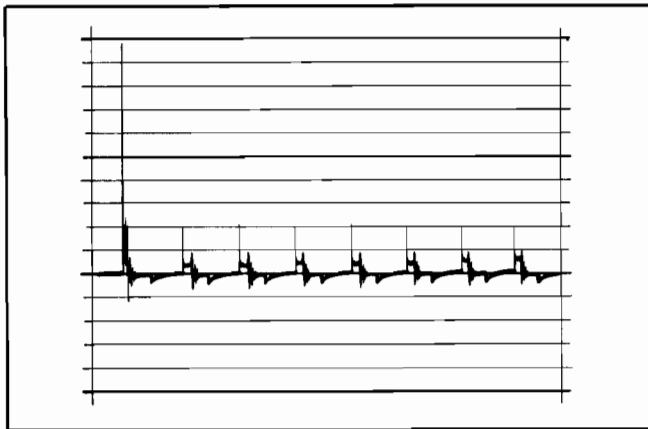
Insufficient available voltage



Excessive Resistance in the Primary Circuit
Low Primary Input Voltage
Defective Coil
Dwell Less than Specified
Defective Secondary Insulation

SECONDARY INSULATION

Short, intermittent, or absent lower extent



INSULATION LEAKAGE IN:

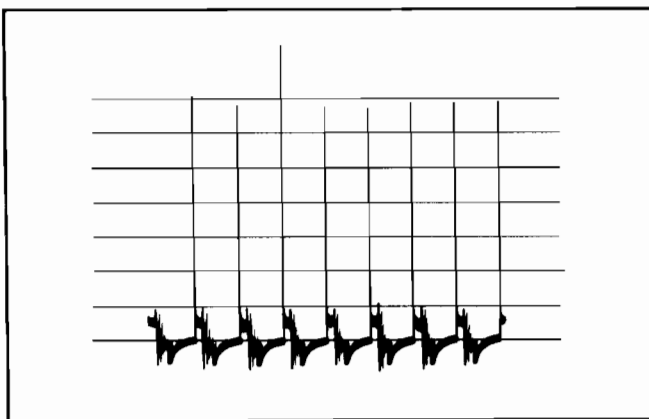
Coil
Coil Tower
Rotor
Coil Wire
Distributor Cap
Spark Plug Wire
(See Below)

ON ALL CYLINDERS:
Coil Tower, Rotor, Coil Wire, or Distributor Cap

ON ONE OR MORE CYLINDERS:
Distributor Cap or Spark Plug Wires

SPARK PLUGS UNDER LOAD

One or more firing lines higher than others

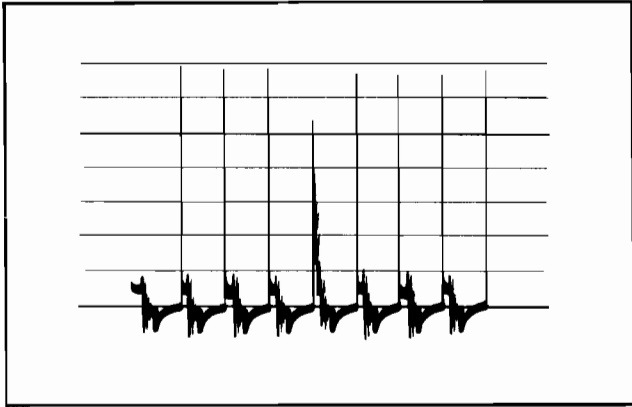


Wide Plug Gap
Open Spark Plug Resistor
Badly Deteriorated Electrodes

SPARK PLUGS UNDER LOAD

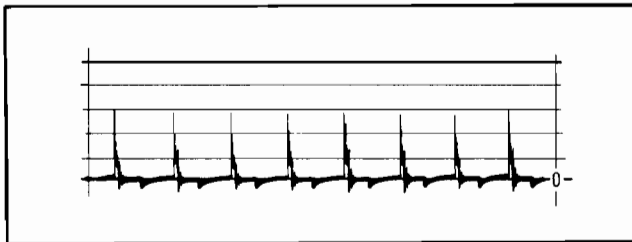
One or more firing lines lower than others

Spark Plug Fouling
Flashover
Cracked Insulator

**SECONDARY RESISTANCE**

Affecting all cylinders

HIGH RESISTANCE IN:
Coil Tower
Coil Wire
Rotor
Distributor Cap Towers
Defective Radio Suppressor



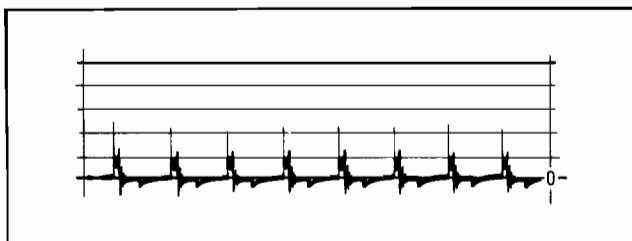
Affecting one or more cylinders

HIGH RESISTANCE IN:
Distributor Cap Towers
Spark Plug Wire
Spark Plug
Radio Suppressor



Affecting all cylinders

Poor Contact Between Rotor and Center
Button of Distributor Cap
Accumulation of Deposits on Spark Plugs



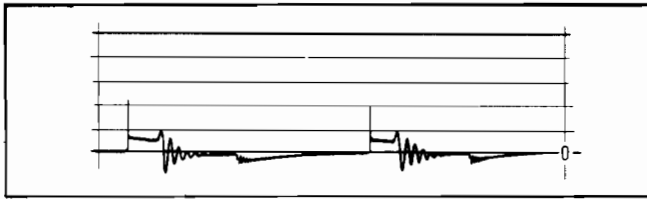
UNSATISFACTORY TEST RESULTS

PROBABLE CAUSES

POINT CONDITION AND ACTION

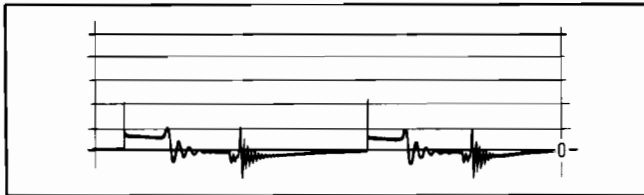
Unusual point close signal

Poor Point Contact or Point Misalignment



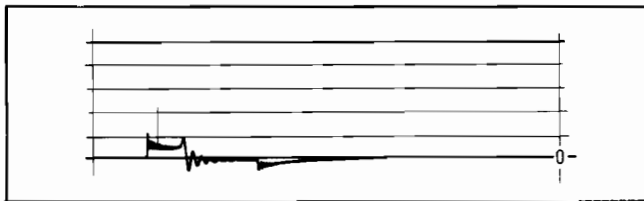
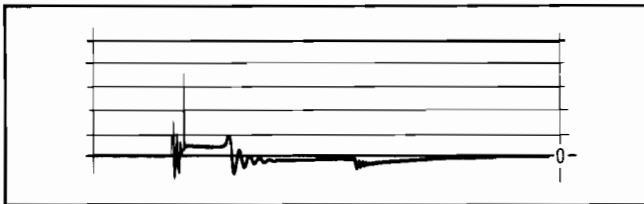
Unusual point close signal

Point Bounce
Weak Point Spring Tension



Unusual point open signal

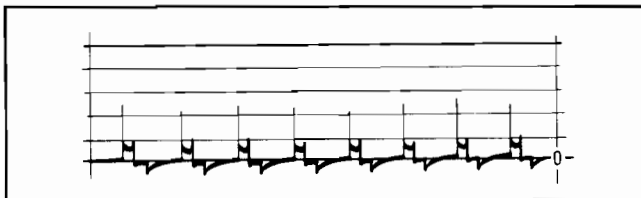
Dirty Points
Burned Points
High Condenser Series Resistance



COIL AND CONDENSER

Lack of oscillations in Intermediate Section

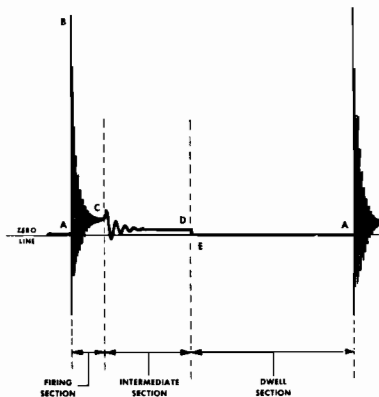
Short in the Coil
Leaky Condenser



PRIMARY WAVEFORM INTERPRETATION

Since any voltage variation in the ignition primary circuit will be reflected in the secondary, it is seldom necessary to use a primary pattern for general ignition testing. If desired, a primary waveform can be displayed on the Sun Scope by substituting the Primary Pattern Pick-up for the Secondary Pattern Pick-up.

The KV scale on the scope screen applies only to the



The primary pattern has the same three basic sections as the secondary:

The Firing Section

This section displays the series of rapid oscillations that take place in the ignition primary circuit during the period of time in which the spark plug fires. Point 'A' represents the instant at which the breaker points separate.

The vertical rise from 'A' to 'B' and the diminishing oscillations which follow, represent the initial and repeated charging and discharging of the condenser and the induced voltage surges in the primary circuit while the spark plug is firing. As the spark bridges the gap and energy is being drained from the coil, the amplitude of these oscillations will diminish until the spark is extinguished as indicated at point 'C'.

display of secondary patterns. Although a resemblance exists between primary and secondary patterns, it should be noted that the voltage values represented in the primary patterns are considerably lower than those represented in the secondary patterns due to the ratio of the primary to secondary windings of an ignition coil.

The Intermediate Section

As in the secondary pattern, the Intermediate Section is seen as a series of gradually diminishing oscillations which disappear or nearly disappear by the time the Dwell Section begins. Beginning at point 'C', what energy still remains in the coil will dissipate itself as an oscillating current which gradually dies out as it approaches point 'D'.

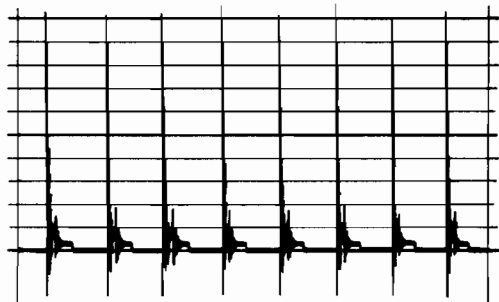
The Dwell Section

The Intermediate Section ends and the Dwell Section begins simultaneously when the distributor contacts close, and can be observed as a faint downward line from point 'D' to point 'E'. The Dwell Section is represented by the horizontal line which extends from point 'E' to the next point 'A', and it is during this period that the points remain closed.

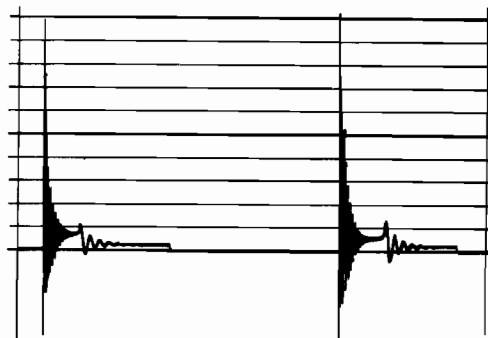
To display primary patterns on the Sun Scope, use the same Connections and Control Settings outlined in "Scope Tests" with the following exceptions:

1. Attach Primary Pattern Pick-up to Scope in place of Secondary Pattern Pick-up.
2. Set Scope Ground Polarity switch in position which corresponds to the ground polarity of the vehicle's electrical system.
3. Observing Polarity, connect Primary Pick-up Leads to distributor primary terminal of coil and to ground.
4. With engine operating at the desired test speed, adjust Pattern Height control until entire waveform is visible on Scope screen.

TYPICAL PRIMARY PATTERNS



ALL CYLINDERS



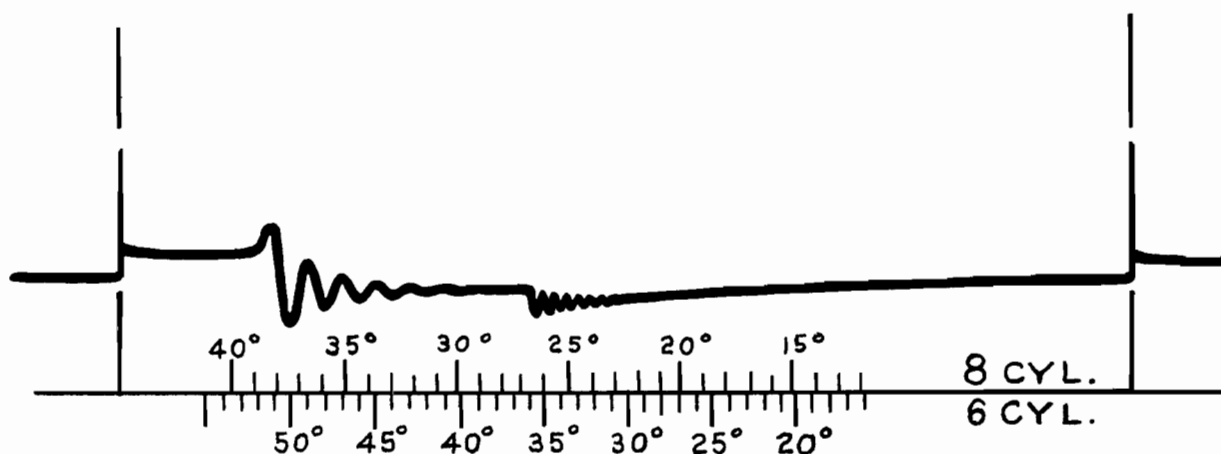
INDIVIDUAL CYLINDERS

SUN SCOPE DWELL TEST

Facilities are provided in the SunScope for measuring distributor point dwell. These facilities may be utilized when displaying either secondary or primary waveform patterns.

Dwell can accurately be measured by expanding the pattern of any one cylinder until it completely fills

the space between the two vertical lines on the screen, then lowering the pattern until it rests on the Dwell Scale. Dwell is measured directly from the scale, which actually consists of two sets of graduations; the upper one for 8 cylinder engines and the lower one for 6 cylinder engines. The dwell of 4 cylinder engines may also be measured by doubling the Dwell reading, obtained from the 8 cylinder scale.



1. With Scope connected and adjusted as outlined in "Scope Tests", set Display Selector to INDIVIDUAL CYLINDER position.
 2. Adjust engine speed to 1200 RPM.
 3. Set Cylinder Selector to FIRST CYLINDER position.
 4. Adjust Horizontal Position control to bring the firing line of the first pattern into alignment with the vertical line at the left of the screen.
 5. Adjust Pattern Length control to bring the next firing line into alignment with the vertical line at the right of the screen.
 6. Adjust Vertical Position control until the pattern rests on the Dwell Scale near bottom of screen.
 7. Measure dwell by noting point on Dwell Scale which is in alignment with the beginning of the pattern's "Dwell Section."
- Refer to specifications for proper dwell.

SUPERIMPOSED SCOPE PATTERNS

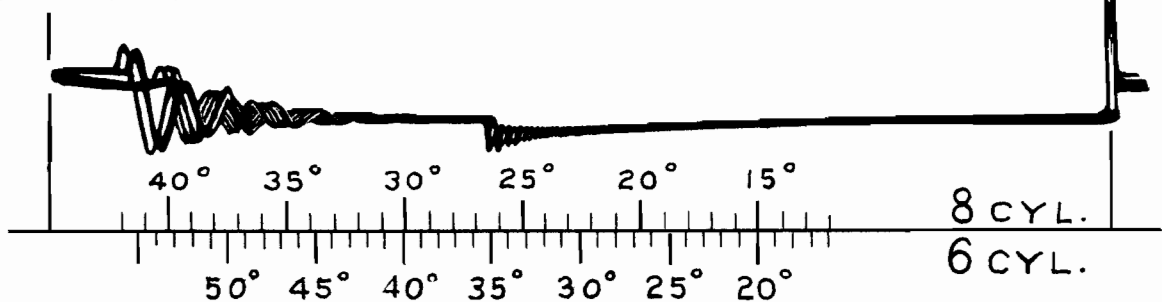
A superimposed pattern is the display obtained by simultaneously placing the patterns of all cylinders one on top of the other. To obtain a superimposed pattern, it is necessary to trigger the Scope each time the ignition points break. This is accomplished by connecting the Trigger Pickup into the secondary circuit between the coil and the distributor cap. Using this method, the operator has a choice of superimposing either a secondary or a primary display by selecting the proper Pattern Pickup.

Superimposing Scope patterns of all cylinders is advantageous in many instances, because it provides a convenient method of testing the ignition system for over-all uniformity. By expanding the display horizontally to completely fill the space between the two

vertical lines on the screen, any variation in the basic pattern sections can quickly be detected.

Lowering the superimposed display until it rests on the Dwell Scale permits any inaccuracy of the distributor cam to be indicated and measured on the Dwell Scale. The accuracy of the distributor cam determines the ignition timing relationship of all cylinders. Should one or more lobes of the distributor cam become worn, or should the distributor shaft be bent, uneven timing of the cylinders would result.

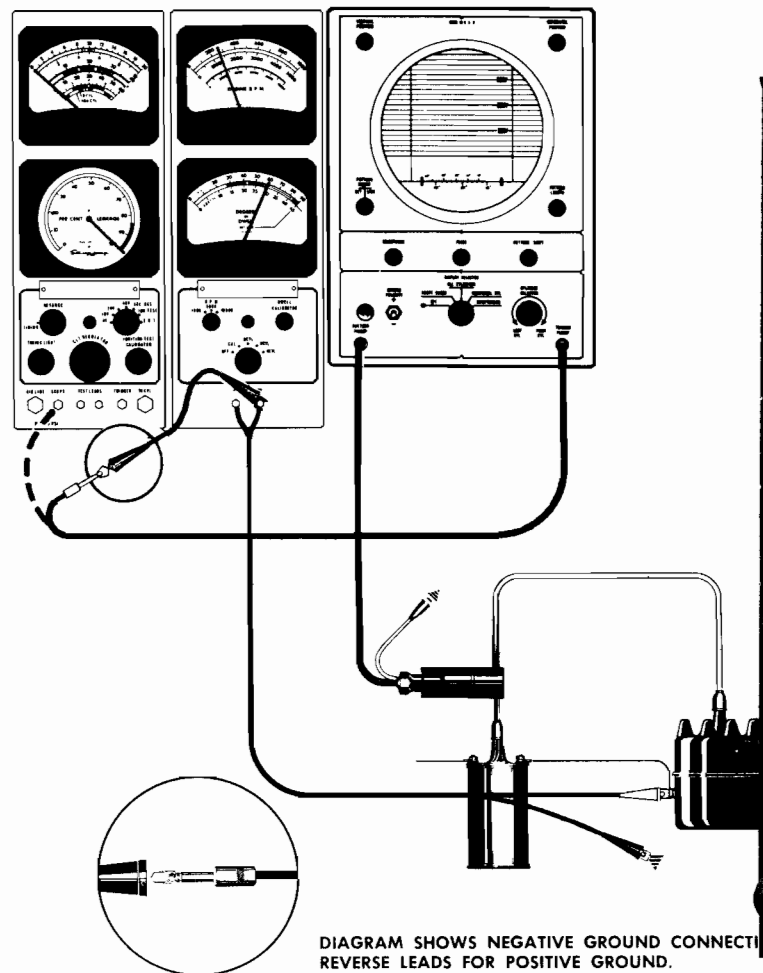
The display illustrated below shows the superimposed patterns of an eight cylinder engine and indicates a total variation of 1/2 degree at the "Point Close" portion of the pattern.



An alternate and simpler method of superimposing patterns is also provided in this Handbook as outlined below.

1. With Scope and Tach-Dwell connected as previously outline, pull Trigger Pickup lead from the Voltage-Leakage Unit.
 2. Connect Jumper lead from insulated tip of Trigger Pickup to ferrule of Tach-Dwell lead that is connected to distributor primary (as illustrated).
 3. With Pattern Shift and Cylinder Selector controls in **FULL CLOCKWISE** position, set Display Selector to **ALL CYLINDERS** position.
 4. Start engine and adjust speed to 1200 RPM.
 5. Adjust Horizontal Position control to align beginning of trace with vertical line at left of screen.
 6. Adjust Pattern Length control to align end of trace with vertical line at right of screen.
- Observe display for uniformity of patterns.
7. Adjust Vertical Position control to locate display midway between **ZERO** line and Dwell Scale near bottom of screen. (For easier observation the Pattern Height may be increased by rotating the control **CLOCKWISE**.)

Observe number of degrees that "Point Close" signals overlap. This should not exceed three degrees.



COMPARISON TEST

During the process of ignition testing the pattern of one cylinder may appear to look different than the patterns of the other cylinders of that engine. The Sunscope permits displaying one pattern above the others for closer examination of differences in pattern characteristics. Differences in individual cylinder patterns are of great value in evaluating engine problems.

To compare patterns on the Sunscope use the same connections and control settings as outlined in "Scope Tests" with the following additions:

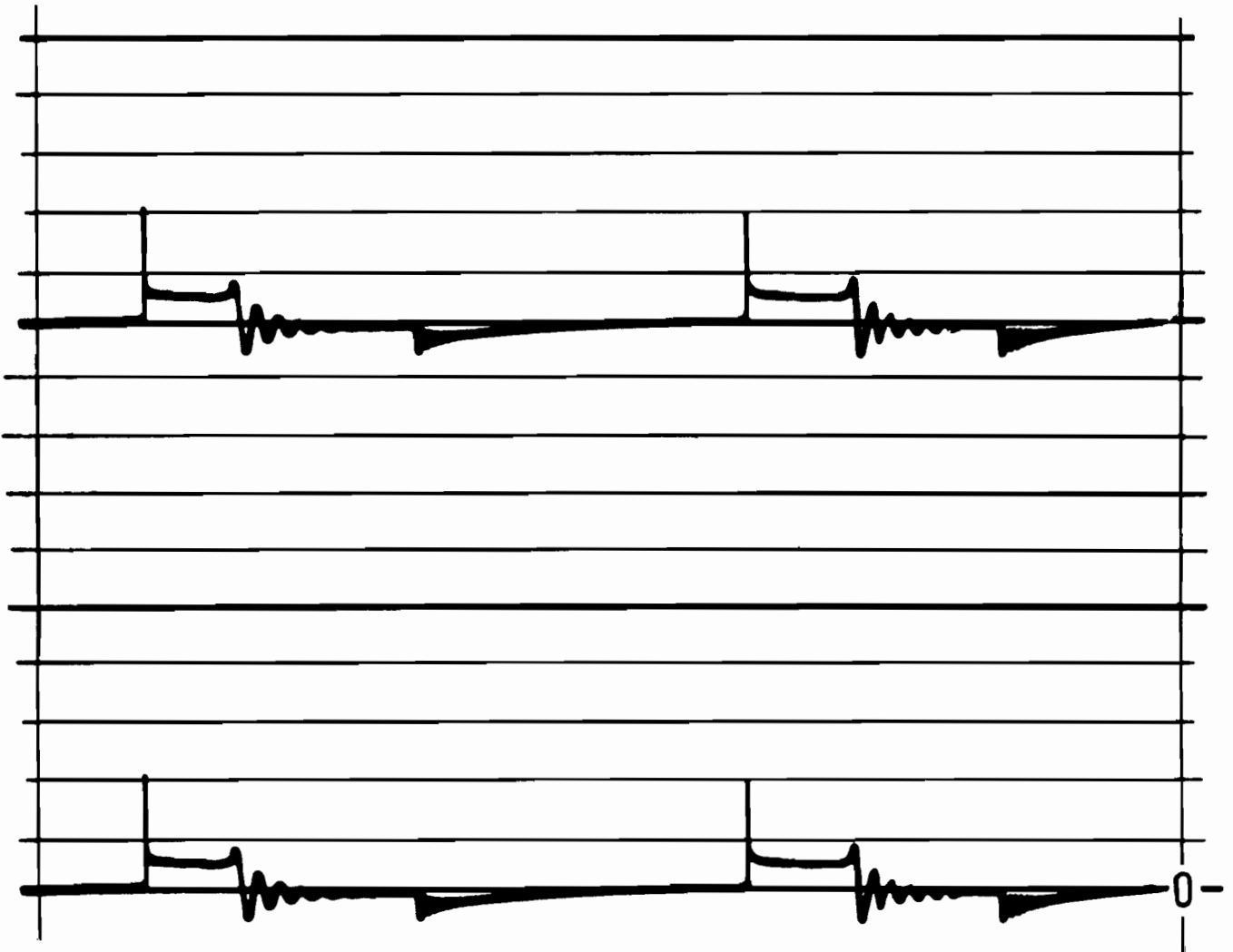
1. After the "Coil and Condenser Test" turn DISPLAY SELECTOR switch to "COMPARISON" position.

2. Turn CYLINDER SELECTOR Control clockwise to first cylinder position.

Both patterns will be of the cylinder in the firing order following the one with the trigger pickup.

3. Rotate Cylinder Selector Counterclockwise and observe bottom Cylinder and compare patterns as they pass in their respective positions in the firing order.

Any Cylinder's pattern can be displayed in the upper position by connecting trigger pickups to the Cylinder preceeding it in the firing order.



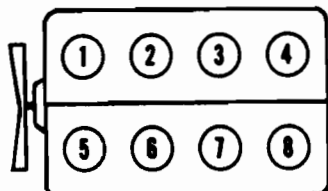
PASSENGER CAR

FIRING ORDERS AND CYLINDER ARRANGEMENTS

Connect Sunscope trigger pickup to suit test procedure used. The cylinder, in the firing order, following the one with the trigger pickup will appear as the first one on scope screen.

FIRING ORDERS

FORD—MERCURY—EDSEL—LINCOLN

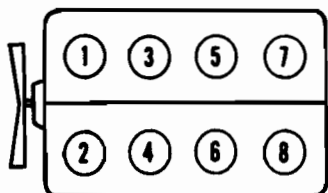


1958 & UP 332 & larger engines

1 5 4 2 6 3 7 8

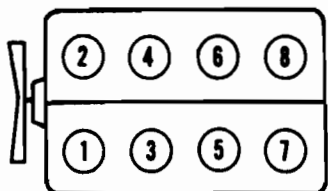
ALL OTHERS & TRUCKS

1 5 4 8 6 3 7 2



BUICK

1 2 7 8 4 5 6 3

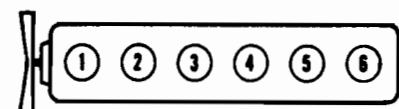


ALL OTHER MAKES

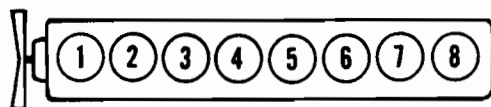
1 8 4 3 6 5 7 2

EXCEPT:

OLDSMOBILES 1 8 7 3 6 5 4 2

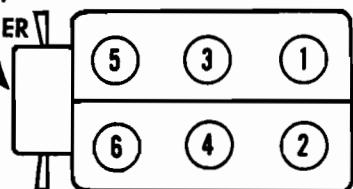


1 5 3 6 2 4



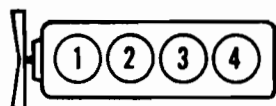
1 6 2 5 8 3 7 4

DIFF.
CARRIER



CORVAIR

1 4 5 2 3 6



TEMPEST

1 3 4 2

CONDENSER—COIL TEST UNIT

MODEL 60

The Model 60 Condenser Coil test unit contains complete facilities for testing ignition type condensers, ignition coils, and is also equipped with a

sensitive triple range Ohmmeter. The three ranges of the Ohmmeter are 0 to 100 OHMS, 0 to 10,000 OHMS and 0 to 100,000 OHMS.

Condenser Tests

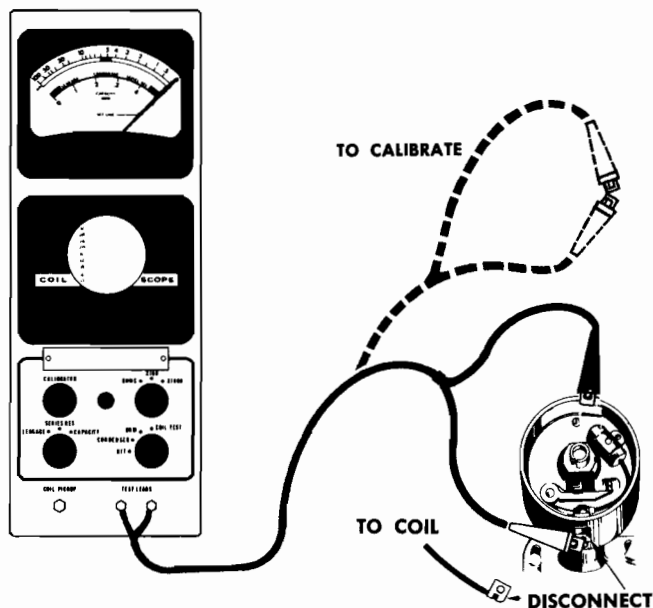
The purpose of the condenser in the ignition system is to prevent arcing and pitting at the breaker points and to aid in collapsing the magnetic field of the ignition coil. In order to function properly and to assure good ignition, the condenser must have three important characteristics.

1. Minimum Series Resistance
2. Correct Capacity
3. Minimum Insulation Leakage

These important factors are conveniently tested with the Model 60 test unit.

Calibration

1. Set Selector Switch to the CONDENSER position.
2. Connect the TEST Leads together.
3. After allowing approximately one minute for tester to warm up, adjust the CALIBRATOR until the meter pointer reads on SET LINE at the right end of the meter scale.
4. After adjusting the pointer to SET LINE, separate the test leads and proceed with the test of the condenser. Do not change the position of the calibrator knob while making condenser tests.



NOTE Ignition condensers may be tested in or out of the vehicle. If they are to be tested in the vehicle, the condenser may be electrically isolated from the balance of the vehicle's ignition system. Disconnect the wire from the primary terminal of the distributor and block the breaker points open with a piece of fiber between the rubbing block and cam as shown in the illustration.

CONDENSER RESISTANCE TEST

1. Connect the test leads, one to the primary terminal of the distributor and the other test lead to ground on the distributor body.
2. With the condenser test switch in SERIES RESISTANCE position, the meter should read in the BLACK BAR at the right end of the scale.

Move the condenser pigtail. If a deflection of the meter is noted, the pigtail is making poor contact and the condenser should be replaced.

If the reading is outside of the BLACK BAR, move the grounded test lead to the body of the condenser. If the reading improves, the condenser is not properly grounded to the distributor housing.

CAPACITY TEST (Microfarad)

1. Turn condenser test switch to CAPACITY position.

2. Read RED scale of meter (0 to .5) for the microfarad capacity of the condenser being tested.

LEAKAGE TEST

1. Turn condenser test switch to LEAKAGE position.

2. The meter should now read in the BLACK BAR at the left end of the scale if condenser insulation is satisfactory.

If meter pointer reads outside of the BLACK BAR, the condenser insulation is leaking and the condenser should be replaced.

Use of Ohmmeter

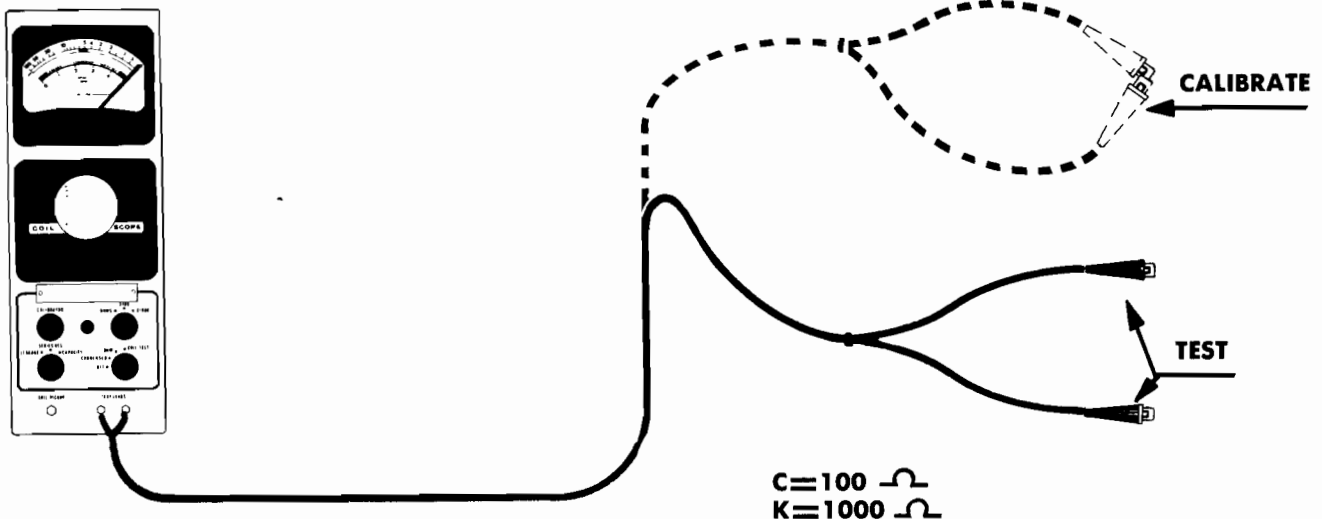
The three Ohmmeter ranges provided in this tester may be used for testing the condition and the continuity of the ignition system and electrical system components. The Ohmmeter scale (uppermost on the meter) reads from right to left and is graduated

3. Refer to manufacturer's specifications for recommended condenser capacity.

If tester reading in microfarads does not fall within tolerances specified, the condenser should be replaced.

IMPORTANT If the condenser does not meet specifications while mounted in the distributor, remove the condenser and retest it. The same procedure is followed whether testing condensers in or out of the vehicle. If the condenser tests "bad" in the distributor, but tests "good" when removed, there is a short or ground in the distributor primary circuit. Inspect the insulation of the distributor primary terminal and the internal circuit of the distributor.

from 0 to 100. With the Ohmmeter selector switch set in the OHMS position, resistance readings are as indicated on the meter. When Ohmmeter selector switch is set in the OHMS x 100 or OHMS x 1000 position, meter readings are multiplied by 100 or 1000 respectively.



PROCEDURE

CAUTION Do not connect the test leads of an Ohmmeter across any source of voltage.

1. Set Selector Switch to the OHM position.
2. Set the Ohm Switch to desired range.
3. Connect test leads together.
4. Adjust CALIBRATOR until meter pointer reads on zero of the OHMS scale.

5. Disconnect test leads and connect them, one to each end of unit or portion of circuit to be tested.

NOTE For accurate test indications, the unit or portion of circuit being tested must be electrically isolated from all other portions of the electrical system.

Resistance Tests of Ignition Coil Windings

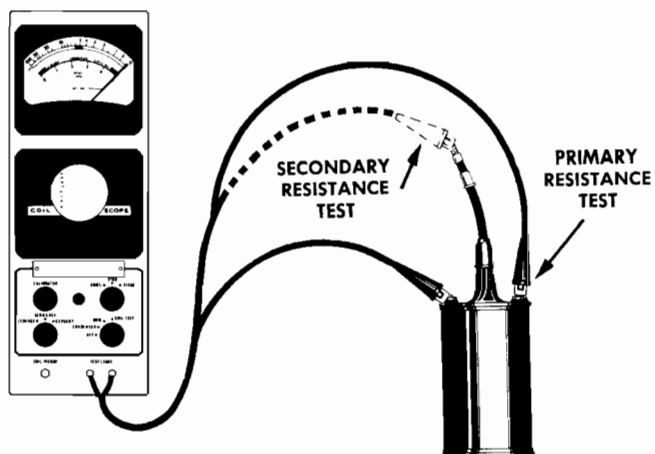
If resistance tests of coil are to be made while the coil is mounted in the vehicle, it must be electrically isolated from the vehicle's electrical system by disconnecting the primary leads from its terminals and removing the secondary lead from the coil tower.

PRIMARY RESISTANCE TEST

1. With the switch set in the OHMS position, calibrate the Ohmmeter.
2. Connect the Ohmmeter test leads, one to each coil primary terminal as shown in the illustration.
3. Observe meter reading and compare with coil specifications.

SECONDARY RESISTANCE TEST

1. With the Ohm Switch set in OHMS x 1000 position, calibrate the Ohmmeter.
2. Install coil terminal test lead in tower of coil.
3. Connect Ohmmeter test leads, one to either primary terminal of the coil and the other to the end of the coil terminal test lead as shown in the illustration.



4. Observe meter reading and compare with coil specifications.

If meter reading exceeds 20,000 OHMS, an open secondary winding is indicated.

ADDITIONAL SUGGESTED APPLICATIONS FOR THE OHMMETER

Use of wiring diagrams of the vehicle or components for reference will aid the operator in making valuable tests for condition and continuity of circuits and components.

1. Circuit continuity...for locating broken wires or poor connections in such circuits as horn, over-drive, turn signals, lights, accessories, etc.
2. Bench Testing...relays, solenoids, switches, etc.

3. Generators (On or Off the vehicle)...for checking generator circuit continuity and field coil resistance.

4. Regulators (On or Off the vehicle)...for locating open resistors or shunt windings.

5. Car radios...antennas, checks for shorts or grounds, tubes for open filaments.

6. Ignition system suppressor resistors...distributor caps, rotors, spark plugs, spark plug wires.

Ignition Coil Tests

The coil test facilities in this unit quickly indicate whether an ignition coil is good or bad. It completely tests six, twelve, and twenty-four volt coils, as well as magneto type coils for opens, shorts, grounds, and insulation breakdown.

To determine whether an automotive type ignition coil is in satisfactory condition, simply follow the procedure as outlined.

The ignition coil test may be performed on or off the vehicle. For on-the-vehicle tests it will be

necessary to electrically isolate the ignition coil from the balance of the ignition system by disconnecting the primary leads from both coil primary terminals and by removing the high tension wire from the coil tower.

1. Set main selector switch to the OHM position. Allow a few seconds warm up.

2. Connect test leads, one to each coil primary terminal. Observe polarity.

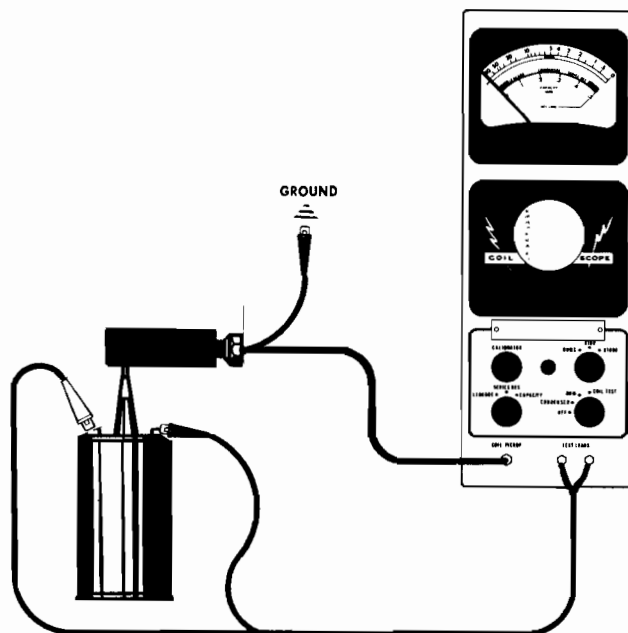
3. Insert coil pickup into secondary tower of coil and connect ground lead of pickup to good ground on vehicle.

4. Turn selector switch to the COIL TEST position and observe wave pattern visible on coil test scope.

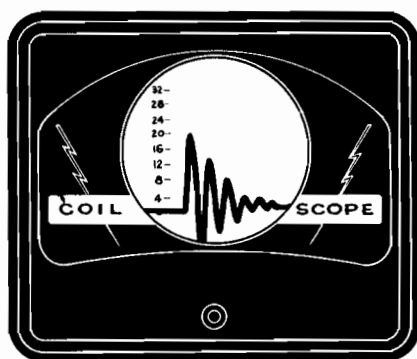
NOTE While a coil is under test the input to the coil may be varied by adjusting the tester calibrator. In this manner the insulation of the coil may be stressed to the degree desired by the operator or specified by the manufacturer. The secondary voltage output of the coil may be measured in kilovolts (1000 Volts) by noting the vertical height of the pattern observed on the 32 KV scale of the coil test scope. Each division of this scale is equivalent to 4 KV.

MAGNETO TYPE COILS

The procedure for testing magneto type coils is similar to that described for automotive type ignition coils as outlined above. It must be brought to the operators attention, however, that in most cases the magneto will have to be at least partially disassembled to permit the test leads to be connected one to each end of the primary winding. A jumper lead may be used to connect the coil pickup to the output end of the magneto coil's secondary winding.

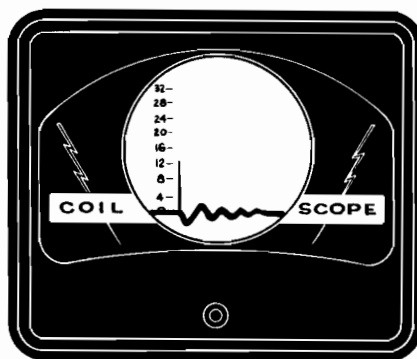


Results and Indications



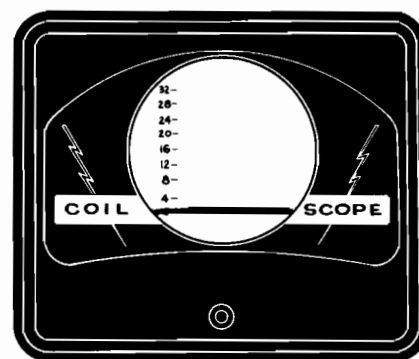
NORMAL

A



SHORTED

B



OPEN

C

Waveform pattern observed on coil scope resembles illustration "A" ... ignition coil in satisfactory condition.

Waveform pattern observed on coil scope similar to the illustration "B" ... ignition coil faulty due to

shorted primary windings, shorted secondary windings, grounded windings, or insulation breakdown.

Waveform pattern observed on coil scope resembles illustration "C" ... faulty coil due to open primary winding.

FUEL PUMP TESTER

In order to assure an adequate quantity of fuel and a constant fuel level for all driving conditions, it is necessary that both Fuel Pump pressure and volume be within specifications. It has been established that the only reliable pressure test is one

that is made under actual operating conditions (i.e., with pump supplying fuel to the carburetor and gauge located within six inches of and connected to the fuel line).

Connections to Vehicle

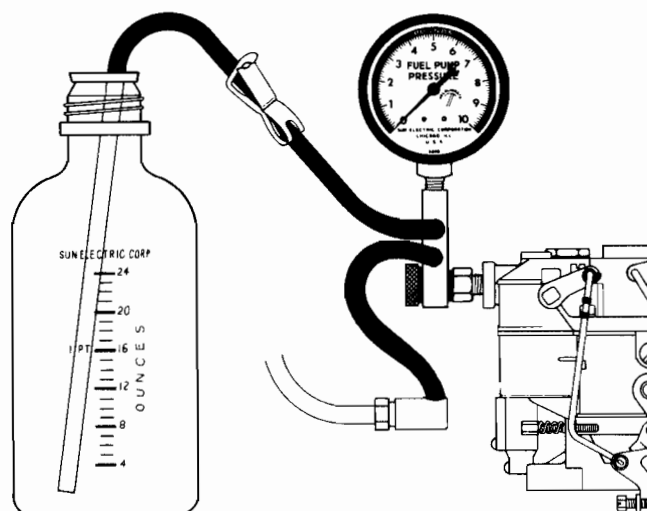
1. Remove vehicle's air cleaner and disconnect main fuel line at carburetor, or at "T" or junction, if vehicle is equipped with more than one carburetor.

2. Mount tester to carburetor inlet with gauge vertical and facing operator. Use adapters if necessary; fittings need only to be "finger tight." (To reverse position of gauge, remove sealing washer and threaded stud from tester body and install from opposite side.)

3. Connect vehicle's fuel line to fitting on fuel pump tester hose. Use adapters if necessary; fittings need only be "finger tight."

4. Close shut-off valve on fuel discharge hose of tester.

NOTE Should it become necessary to calibrate the fuel pump tester, hold the gauge in a vertical position, insert a screwdriver through the opening in the front of the gauge and adjust until the pointer reads "Zero."



Pump Pressure and Volume Test

1. Start engine and adjust speed to approximately 500 RPM, unless specified otherwise.

2. Insert volume test hose into graduated container and open shut-off clamp. When fuel reaches the 4 oz. level in the container, submerge the end of the hose in the fuel and observe for bubbles.

3. Note the time required to pump one pint of fuel

then close shut-off clamp securely. (Be sure to dispose of fuel in graduated container to avoid fire hazard.)

4. With engine still running at test speed, note gauge reading on fuel pump tester.

5. Compare volume and pressure test readings with vehicle's specifications.

Results and Indications

Pressure and Volume within specifications...
Pump and fuel lines in satisfactory condition.

Pressure and volume low...defective pump, restricted or leaky line.

Pressure low with correct volume...defective

pump, (pressure spring too weak).

Insufficient volume with normal pressure...restricted or leaky fuel line, defective pump (stroke too short).

Air bubbles on volume test...leaky fuel line, leaky pump.

COMBUSTION-VACUUM TEST UNIT

MODEL 80

Vacuum Gauge

The Vacuum Gauge provides facilities for testing intake manifold vacuum, cranking vacuum, fuel pump vacuum and booster pump vacuum. Properly used, the vacuum gauge will indicate to the user if other tests are necessary. Because of its general nature, the vacuum gauge does not replace other

more specialized test equipment, but rather supplements it. For the convenience of the user in servicing foreign cars and utilizing data listed by foreign manufacturers, the vacuum gauge is also graduated in millimeters of mercury. This scale is located on the inner circle of the vacuum gauge.

Manifold Vacuum Test

The Manifold Vacuum test provides an overall check on the engine condition based on comparison of readings obtained with known standards for the engine being tested. Any loss of power or efficiency in the engine will affect the manifold vacuum reading.

1. Connect a tachometer to the engine. (Refer to the Tach-Dwell section of this Handbook.)

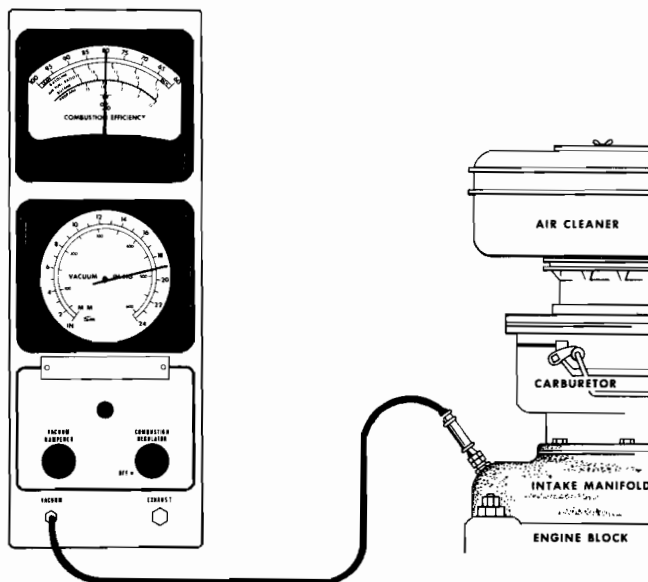
2. Connect vacuum gauge hose to the engine's intake manifold, using proper adapter if necessary.

NOTE: On vehicles with vacuum booster, be sure the tester hose is connected directly to the intake manifold.

3. Start engine and run until normal operating temperature is reached.

4. With engine operating at specified idle speed, note manifold vacuum. If gauge pointer flutters rapidly, adjust Vacuum Dampener until gauge responds freely, but does not flutter excessively.

NOTE: Experience is the best guide in determining the normal vacuum for any given engine. Normal manifold vacuum ranges from 15 to 22 inches on various engines. On late model engines, lower and less steady manifold vacuum is increasingly common because of the greater use of high lift cams and more valve overlap.



Results and Indications

Engine running smoothly at specified idle RPM, vacuum readings average and steady... engine, ignition system, and fuel system operating normally.

Vacuum reading lower than normal, but steady... late ignition or late valve timing, low compression, valves improperly adjusted, excessive mechanical drag in engine.

Vacuum reading abnormally unsteady... improper carburetor idle mixture, distributor point spacing, spark plug gapping, choke adjustment, or valve adjustment. Poor plug or carburetor condition. Manifold air leaks, defective valves, or uneven compression.

Exhaust Restriction Test

This test is used to determine whether the exhaust system is restricted, or offers excessive back pressure which could result in reduced engine efficiency.

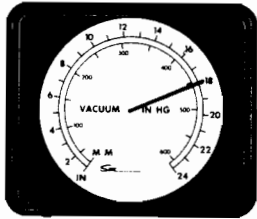
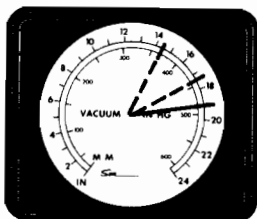
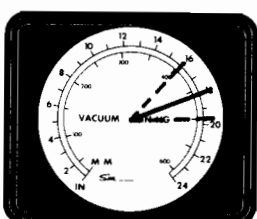
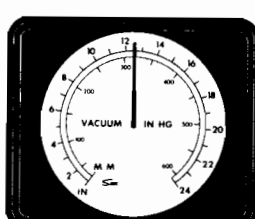
1. Connect vacuum gauge and tachometer to engine as per manifold vacuum test.

2. Gradually accelerate engine from idle to 2000 RPM.

3. Note vacuum gauge reading.

4. Maintain engine speed at 2000 RPM for approximately 10 seconds or longer while observing the vacuum gauge.

If exhaust system is restricted, the vacuum reading will gradually decrease.

 With motor at idling speed vacuum pointer should hold steady between 15 and 22.	 Accelerate engine from idle to 2000 RPM, then observe reading for approximately 10 seconds. Dropping back of vacuum pointer indicates restricted exhaust system.	 With motor at idling speed floating motion right and left of vacuum pointer indicates carburetor too rich or too lean.	 With motor at idling speed low reading of vacuum pointer indicates late timing or intake manifold air leak.
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Cranking Vacuum Test

An even, steady vacuum during cranking indicates a mechanically sound engine, properly sealed intake manifold and intake valve guides, and a normal cranking speed. Even though individual design characteristics of different engines cause a normal cranking vacuum to vary considerably, the results of this test have been found to be extremely valuable as a guide in determining compression factor conditions and intake system leakage.

1. Engine should be at normal operating temperature.

2. Connect a jumper lead from the distributor

primary terminal to ground, to prevent the engine from starting during this cranking operation.

3. Back out throttle stop screw and release automatic choke so that throttle valves can seat tightly.

4. Crank engine, note vacuum gauge readings and observe cranking speed.

Readings should be average for the make and model of engine being tested. Readings will pulsate slightly, but should be even. Cranking speed should be normal and steady.

Results and Indications

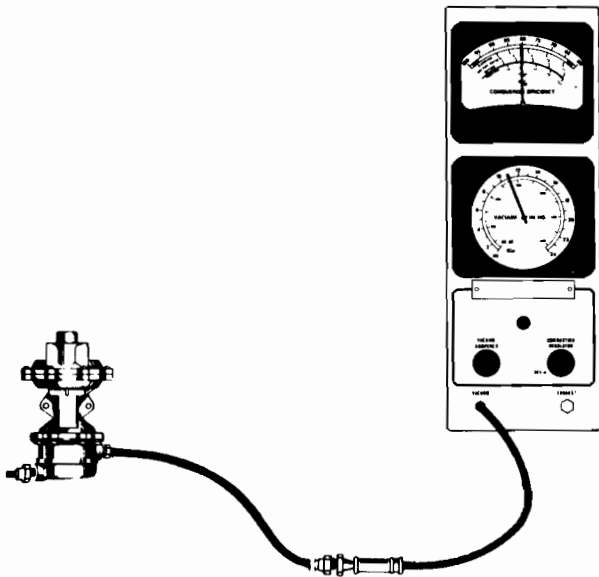
Even, steady vacuum reading...mechanically sound engine, intake manifold gaskets and valve guides in good condition, cranking speed satisfactory.

Uneven pulsating reading...defective valves, rings, pistons, head gasket, or uneven cranking speed.

Low, even reading...slow cranking speed, overall low compression, incorrect valve timing, throttle valves not tightly closed, vacuum leaks at intake valve guides, manifold, or vacuum accessories.

Fuel Pump Vacuum Test

The Fuel Pump Vacuum test is an auxiliary test that is necessary only when the pump output does not meet the pressure or volume specifications. The fuel pump vacuum test is made to determine whether the defect is in the pump or in the fuel line.



Vacuum Booster Pump Test

The purpose of the vacuum booster section of the fuel pump is to operate the windshield wipers during periods of acceleration and at high speeds when manifold vacuum is too low for proper wiper action. A complaint of improper wiper action may be due to stuck valves or ruptured diaphragm in the booster pump. A ruptured diaphragm can also cause an engine miss (due to a lean air-fuel mixture), fouled plugs, a smoky exhaust, or high oil consumption.

1. Disconnect vacuum line between booster pump and intake manifold.

Cranking speed below normal...excessive resistance in battery cables, defective starting motor, excessive mechanical drag in engine.

Uneven cranking speed...uneven compression, defective starter, defective starter drive.

NOTE: If cranking vacuum is low or uneven, make cylinder leakage or compression tests. Satisfactory engine performance cannot be obtained until any compression or vacuum leaks that exist have been eliminated.

1. Disconnect fuel pump flexible line from tank fuel delivery line.
2. Install proper adapter fitting in flex line and attach vacuum gauge hose.
3. Start engine and operate at idle speed.
4. Run engine for a period of time, sufficient to permit the vacuum gauge to reach its maximum reading.
5. Stop engine and observe the vacuum gauge for 10 or 15 seconds.

If maximum vacuum is 10 inches or more, and does not fall off when the engine is stopped, the flex line, pump valves, and filter bowl gaskets do not leak.

If maximum reading is less than 10 inches or vacuum falls off rapidly, remove flex line and couple vacuum gauge directly to the inlet opening of the fuel pump and retest the pump.

NOTE: The entire line from the fuel tank can be tested for air leaks in a similar manner by connecting the vacuum gauge hose to the fuel line at tank end of the line, and repeating the test. A rapid fall-off of vacuum after the engine is stopped would indicate air leaks into the line somewhere between the tank and the fuel pump.

2. Remove windshield wiper hose from inlet of booster pump, and connect vacuum gauge hose to the pump inlet.
3. Connect a tachometer to the engine. (Refer to the Tach-Dwell section of this Handbook).
4. Operate engine at 1000 RPM. Vacuum reading generally should be 8-1/2" or more if the booster pump is operating satisfactorily.
5. Stop engine and observe vacuum gauge for a short period of time. A rapid fall-off of the vacuum gauge reading would indicate air leaks in the pump, pump valves, tester connections, etc.

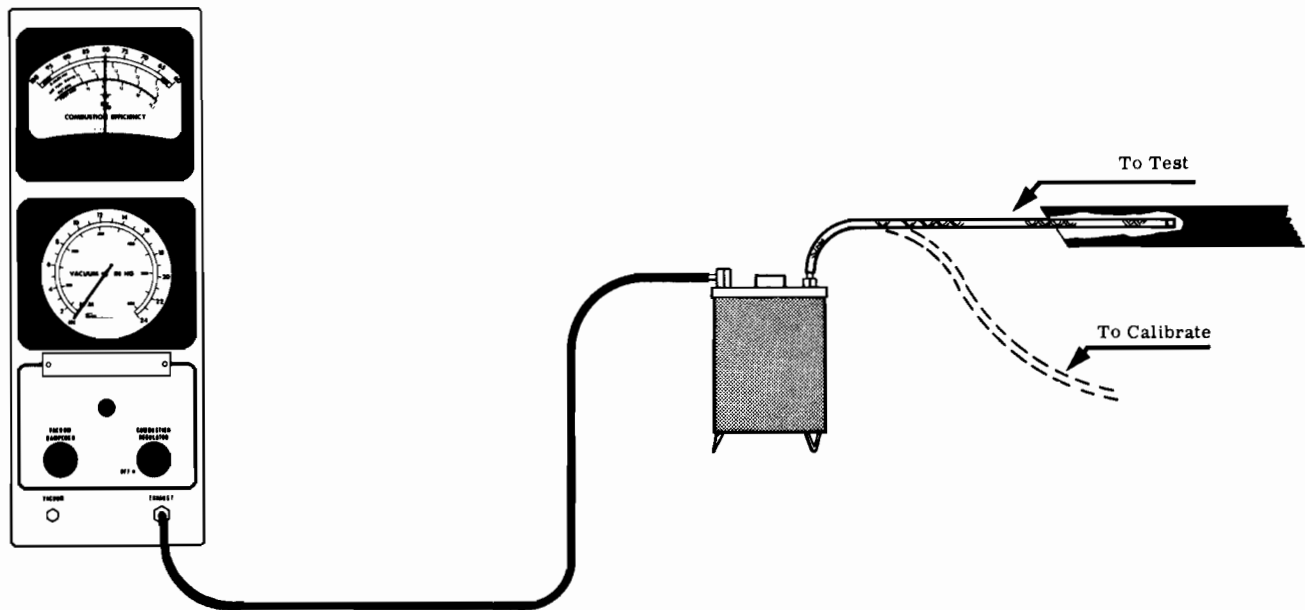
Combustion Efficiency Tests

Combustion efficiency is a very reliable indication of carburetor system operation on a mechanically sound, properly timed engine with a good ignition system. Combustion efficiency is tested by utilizing exhaust gas samples picked up at the tail pipe to determine the fuel to air ratio, and indicate this information on an electric meter. To obtain accurate test results, the engine must be at operating temperature.

Before testing, determine that both compression and ignition of the engine are in good condition, and that the exhaust system does not leak in order to assure accurate results.

While oil smoke from a car does not materially affect the accuracy of the tester during the test, repeated use of a combustion efficiency tester on oil burning engines will eventually decrease its sensitivity because of oil fouling.

Preparation For Tests



1. Connect a tachometer to the engine. (Refer to the Tach-Dwell section of this Handbook).
2. Connect the vacuum gauge to the intake manifold.
3. With power cord of tester plugged into a suitable receptacle, set Master switch to ON position.
4. Rotate Combustion Regulator clockwise from OFF position, and allow unit to warm up.

5. Connect one end of neoprene hose to exhaust condenser, and the other end to fitting on Combustion Vacuum unit.

6. Adjust Combustion Regulator until meter pointer reads on SET LINE. (80%).

7. Insert metal pickup hose of exhaust condenser into tail pipe of vehicle. (With dual exhaust, use side opposite manifold heat control valve).

Idle Mixture

1. Adjust engine speed to specified idle RPM.
2. Note reading on combustion efficiency meter. The most desirable idle mixture for the majority of passenger vehicles is 72 to 76 per cent.

3. Make fine adjustments, moving each carburetor idle mixture screw to obtain the desired setting.

4. Note idle speed and reset as necessary to manufacturer's specifications.

Results and Indications

Idle mixture reading ranges from 72 to 76 per cent...idle speed and idle mixture screw settings satisfactory.

Too lean (to the left)...incorrect idle mixture adjustments, low float level, plugged idle jets or air leaks.

Too rich (to the right)...incorrect idle mixture

Intake Manifold Leak Test

1. Using a squirt can, apply a mixture of engine oil and kerosene to the carburetor flange gasket and intake manifold gaskets. (Do not apply this mixture near the choke heat riser tube as it will cause a false meter indication).

2. Observe combustion meter for any unusual

Results and Indications

No observed meter deflection...manifold and gaskets airtight.

Meter pointer deflects more than 3 per cent to

Carburetor Mixture Curve

1. Accelerate engine slowly, pausing at each designated speed long enough to permit combustion efficiency meter to stabilize and observe for reading recommended:

RPM	COMB. EFF.
800	
1000	78% - 82%
1200	

adjustment, high float level, or plugged air bleeds.

Little or no change in meter reading when idle mixture adjustment is changed...plugged idle passages or carbon over idle ports.

Meter reading drifts...worn needle and seat, fuel pullover from high speed nozzle or accelerator pump jet, improper float level, or leaky power valve.

deflections towards the rich side (right).

CAUTION Because this mixture is combustible, care should be exercised in its use. Keep a fire extinguisher handy.

the right (rich)...leaky intake manifold gaskets, cracked or warped intake manifold, loose carburetor, or loose manifold mounting bolts.

NOTE: These readings have been found the most desirable for economy during no load carburetor testing as pertaining to most passenger cars and light trucks.

RPM	COMB. EFF.
1500	
1800	84% - 88%
2000	
2200	

Results and Indications

Meter reading within specifications for listed engine speeds...carburetor action satisfactory.

Too lean (to the left)...low float level, incorrect metering rod adjustment or metering jets, plugged high speed passages or jets, manifold or carburetor air leaks.

Too rich (to the right)...high float level, leaky

power valve, leaky accelerator pump or check valve, incorrect metering rod adjustment, incorrect metering jets, plugged air bleeds or restricted air cleaner.

Meter reading drifts...worn needle and seat, Fuel pullover from: high speed nozzle, accelerator pump jet, improper float level, or leaky power valve.

Accelerator Pump Test

1. Set engine speed to 1000 RPM and allow combustion reading to stabilize.

2. Accelerate quickly to approximately half

throttle and lower speed back to 1000 RPM.

3. Observe combustion meter for amount of temporary enrichment (deflection to the right). Should be minimum of 8 per cent.

Results and Indications

Meter shows a minimum of 8 per cent temporary enrichment...accelerator pump action satisfactory.

Air Cleaner Test

1. With engine operating at 2000 RPM;
 - a. Observe combustion meter reading with air cleaner in place on carburetor.
 - b. Observe combustion meter reading with air cleaner removed from carburetor.
2. Compare meter readings observed in previous step.

Results and Indications

Little or no difference indicated in the two meter readings just observed...air cleaner not restricting flow of air.

Greater than 5 per cent difference noted in the two meter readings just observed...air cleaner

Little or no change in meter reading...insufficient pump stroke, leaky check valve, worn linkage, or worn plunger.

restriction is indicated.

NOTE Some air cleaners have built-in restriction which will cause considerable leanness of the air-fuel ratio when the air cleaner is removed. Consult manufacturer's data.

Final Idle Adjustment

1. Reduce engine speed to idle.
2. Observe idle RPM, combustion efficiency reading and vacuum readings.
3. Adjust carburetor idle mixture for highest, smoothest vacuum. Idle should be smooth with mixture and speed within specifications.

Results and Indications

High, steady vacuum, mixture and speed within specifications...proper carburetor adjustment, correct timing.

Vacuum reading lower than normal but steady...late ignition timing, late valve timing, low compression or excessive mechanical drag in engine.

Vacuum reading abnormally unsteady...improper carburetor idle mixture, distributor points faulty, spark plugs improperly gapped, faulty valve adjustment, fouled or dirty spark plugs, manifold

NOTE Experience is the best guide in determining the normal vacuum for any given engine. Normal manifold vacuum ranges from 15" to 22" on various engines. On late model engines, lower and less steady vacuum is increasingly common, because of the greater use of high lift cams and more valve overlap.

air leaks, uneven compression, or improper carburetor action.

After completing the test series, stop engine before disconnecting test leads, pickups, hoses, or accessories required for performing the tests. Be sure all vehicle electric, fuel, and vacuum connections are secure before restarting the engine.

NOTE Allow combustion tester to operate approximately 5 minutes after removing the hose to expel any moisture that has accumulated in the unit.

LOAD TESTING

Passenger Cars

The Combustion-Vacuum Tester will make accurate tests of combustion efficiency in an engine operating under load on a dynamometer up to an air-fuel ratio of 15 to 1. The proper air-fuel ratio for load tests on passenger cars is best deter-

mined by comparison tests and experience with several engines of the same make and model. Consideration must be given to engine conditions, temperatures, grades of fuel, etc.

Trucks

Full load, full throttle readings of 82 to 84 per cent combustion efficiency, or 13.5 to 1 to 13.8 to 1 air-fuel ratio, are as high as is practical for truck engines. Leaner mixtures result in valve trouble and detonation. Since the full power system is generally not in operation at speeds of 2000 RPM no-load, when practical, it is suggested that combustion efficiency tests under full load conditions be performed in addition to the no-load tests.

A 14.5 to 1 air-fuel ratio, or 87.5 per cent combustion efficiency reading is satisfactory for part throttle operation with the truck under road-load, but it is too lean for sustained open throttle runs. The test equipment operator should be guided by the truck manufacturer's specifications for combustion efficiency under various loadings.

Dynamometer Testing

If the Combustion-Vacuum Tester is used in conjunction with a dynamometer to determine combustion efficiency of the engine at various loads, an auxiliary condenser must be used to prevent moisture from entering the tester element. When

making dynamometer tests it is a good practice to remove the pickup hose from the tester panel, except for periods when actual test data is being recorded. This is a very effective means of keeping moisture out of a tester element.

L. P. Engine Testing

When testing engines designed to operate on butane or propane fuels, read the air-fuel ratio on the designated scale of the tester meter.

Specifications for the air-fuel ratio of propane and butane on specified engines may be obtained from the various engine manufacturers, as well as propane and butane gas suppliers.

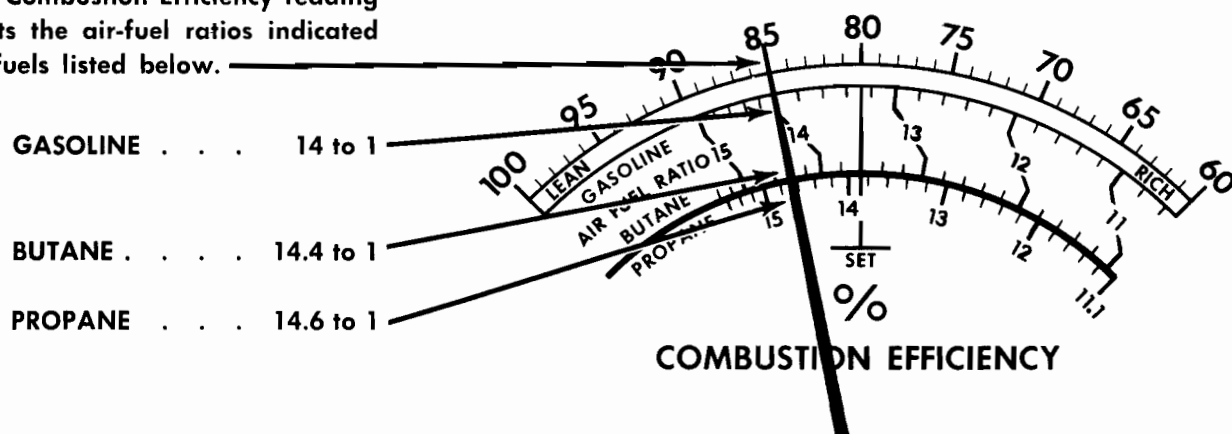
Multi-Carburetor Installations

The Combustion-Vacuum Tester is ideal for adjusting multi-carburetor installations. With throttle linkage disconnected and the engine operating at a

fixed speed on each carburetor in turn, the combustion efficiency readings should be consistent.

HOW TO READ THE COMBUSTION METER

An 85% Combustion Efficiency reading represents the air-fuel ratios indicated for the fuels listed below.



The "percent of combustion efficiency" scale of the tester is provided as a convenient reference, and

is based theoretically on the complete burning of fuel and at any given ratio of fuel and air.

Use and Care of The Combustion Tester

A Combustion Tester is a precision instrument and, like any precision instrument, must receive proper care if long life and accuracy are to be obtained.

Never use the Combustion Tester on an engine while gum solvents or oils are being introduced into the combustion chamber through the carburetor, or by any other means. Do not use the Combustion Tester on an engine that is burning oil badly. The oil leakage must be stopped before efficient combustion can be obtained. Oil smoke will decrease the sensitivity of a Combustion Tester.

Check the vehicle for exhaust leaks at manifolding, exhaust gaskets, exhaust pipe, muffler or tail pipe. Leaks will allow the exhaust gases to be

diluted with outside air, causing meter test readings to be inaccurate. Always insert the pickup tube as far as possible into the tail pipe of the vehicle.

After completing the combustion tests, pull the exhaust hose off the meter panel and allow the booster to continue running for about 5 minutes to evaporate any trace of moisture in the instrument.

Drain all water from the hose and the pickup and remove the water from the auxiliary condenser if used, then place the hose in a dry place.

CAUTION Under no conditions should compressed air be used in an attempt to remove moisture from the tester.

GENERATOR FIELD CONTROL

The Generator Field Control provides a convenient means of varying generator output without changing the vehicle's engine speed. It is equally applicable to either D.C. or A.C. systems.

As indicated in other sections of this Handbook, (i.e., Sun Scope, Combustion Efficiency Tester, Volts Ignition Tester, and Coil Circuit Tester) for the purpose of providing stable test conditions, it is necessary to prevent the generator from producing electrical power while certain tests are being performed. By using the Generator Field Control in the prescribed manner, generator output can be reduced to zero without danger of damage to any charging system component. The operator has full control of generator performance at all times.

NOTE Engine must be stopped when connecting or disconnecting the Generator Field Control.

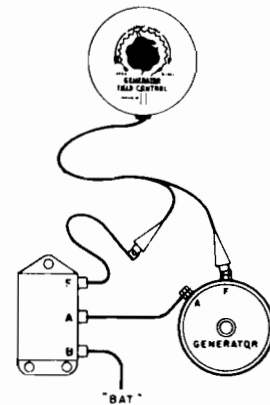
1. Disconnect Charging System Field Circuit, either at generator (alternator) or at regulator, whichever connection is more accessible.

2. Connect the leads of the field control, one to the end of the vehicle's field wire, the other to the field terminal. (Refer to illustration.)

3. Set Generator Field Control Knob to its OPEN position. (Generator will now be inoperative.)

4. Start engine and proceed with tests in their prescribed manner.

5. Should it be desired that the generator operate at regulated voltage, such as for "Charging Voltage Test", gradually rotate the Field Control Knob to its DIRECT position. (Generator voltage will increase until it reaches maximum value permitted by the setting of voltage regulator.)



Additional Uses

The Generator Field Control, used with a Volts-Ampere Tester, provides a convenient means of

controlling generator operation when performing tests of generator output and cutout relay functions.

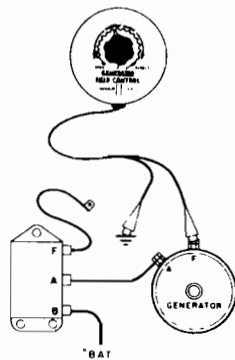


Fig. A

1. Connect Generator Field Control as illustrated:-

Illustration A - for systems having field circuit grounded externally.

Illustration B - for systems having field circuit grounded internally.

2. For Generator Output Test - operate engine at specified RPM, set generator field control to its

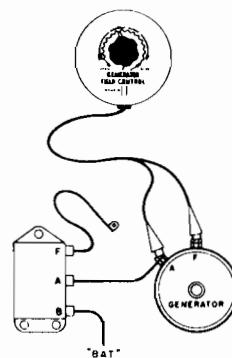


Fig. B

DIRECT position and observe test ammeter for generator output in amperes.

3. For Cutout Relay Tests - operate engine at approximately 1000 RPM, gradually rotate field control from OPEN towards its DIRECT position, while observing test voltmeter for reading of voltage required to close the cutout relay. After closing voltage has been tested, slowly rotate field control from DIRECT towards its OPEN position, while observing test ammeter for reading of reverse current necessary to open cutout.